NUEXCO

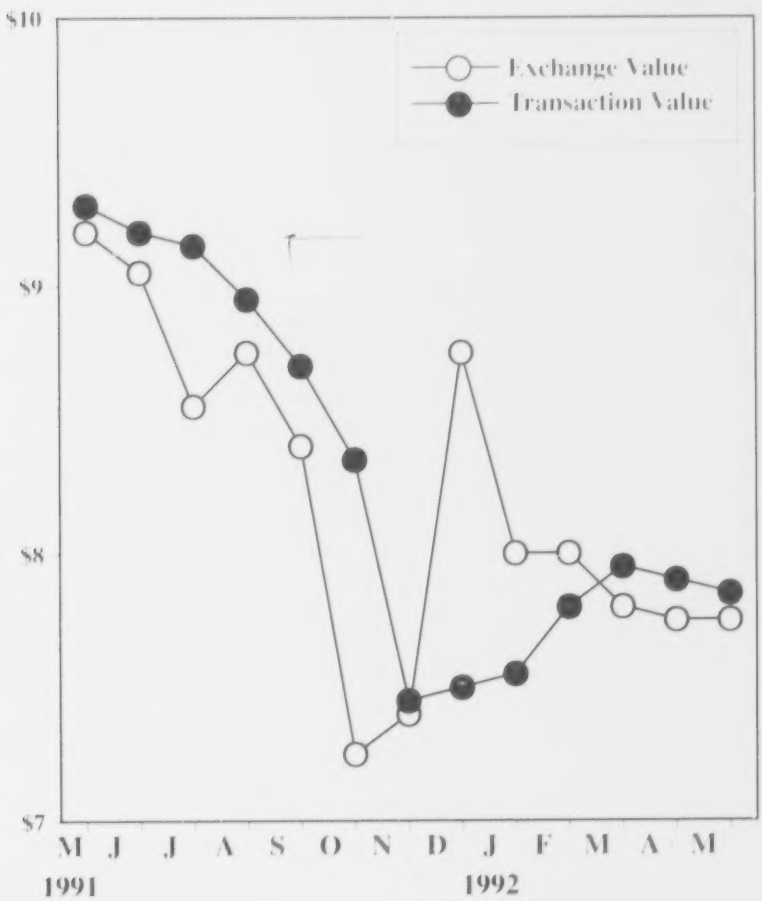
Monthly Report

June 1992 **Number 286**

DOC Anti-Dumping Preliminary Determination 14

Transporting Uranium Fuel 21

Nuclear Fuel Reprocessing 29



NUEXCO

International Headquarters

Oren L. Benton – Chairman
Earl E. Hoellen – Vice-Chairman and Chief Executive Officer
James J. Graham – President and Chief Operating Officer

Three Park Central, Suite 1000
1515 Arapahoe Street
Denver, Colorado 80202 USA

Telephone: (303) 899-4500
Fax: (303) 899-4555
Telex: 450202 (NUEXCO)

Service Locations

LONDON, ENGLAND
NUEXCO Resources, Ltd.
The Exchange
71 Victoria Street
London, SW1H OHW England
Telephone: (44-71) 233-3083
Fax: (44-71) 233-3085
Telex: 267139 (299935 CCC G)

ZURICH, SWITZERLAND
NUEXCO Exchange AG
Leberngasse 15
4603 Olten, Switzerland
Telephone: (41-62) 320032
Fax: (41-62) 321450
Telex: 981600 (NUXCH)

MOSCOW, RUSSIA
Bolshoy Cherkasskiy pereulok 4
Moscow, 103012
Russia
Telephone: (7-095) 924-2757
(7-095) 921-2722

DENVER, COLORADO, USA
Three Park Central, Suite 1000
1515 Arapahoe Street
Denver, Colorado 80202
Telephone: (303) 899-4500
Fax: (303) 899-4555
Telex: 450202 (NUEXCO)

SAN FRANCISCO, CALIFORNIA, USA
Building 1, Suite 105
3000 Sand Hill Road
Menlo Park, California 94025
Telephone: (415) 854-1510
Fax: (415) 854-2115
Telex: 470674 (NUEXCO SF)

HONG KONG
NUEXCO Asia, Ltd.
1408 Shui On Centre
6-8 Harbour Road
Wanchai, Hong Kong
Telephone: (852) 824-3312
Fax: (852) 824-3320
Telex: 67206 (CNITC)

SYDNEY, AUSTRALIA
Suite 2301 – Gateway
One Macquarie Place
Sydney, New South Wales 2000
Australia
Telephone: (61-02) 247-9999
Fax: (61-02) 247-9437

WASHINGTON, D.C., USA
11 Dupont Circle,
Suite 505
Washington, D.C. 20036
Telephone: (202) 328-9250
Fax: (202) 328-6699
Telex: 451691 (NUEXCO DC)

NOTICE

This Report is prepared especially for Subscribers and is furnished to them for their use only. Except for internal use by Subscribers, no part of this publication may be reproduced, stored in a retrieval system, or transmitted, in any form or by any means, electronic, mechanical, photocopying, recording or otherwise, without the prior written permission of NUEXCO. Neither this Report, nor copies of any portion thereof, may be lent, sold or given to non-Subscribers.

The information in this Report was gathered from sources NUEXCO believes to be accurate. However, NUEXCO makes no warranty, express or implied, and assumes no legal liability or responsibility for the accuracy, completeness or usefulness of any information contained herein.

© 1992 NUEXCO

ISSN 0742-4582

NUEXCO Monthly Report

June 1992
No. 286

Published by:
NUEXCO
Three Park Central
Suite 1000
1515 Arapahoe Street
Denver, Colorado 80202 USA
Telephone: (303) 899-4500
Fax: (303) 899-4555
Telex: (303) 450202 (NUEXCO)

Managing Editor
Treva E. Klingbiel

Assistant Editor
Kenten D. Lindberg

Production
Alan L. Wolcott

Subscriptions
Sandra K. Lauer

TABLE OF CONTENTS

Market Review 1
- Market Values Summary
- May Market Review
- Current Market Data

Recent Developments 14
- DOC Anti-Dumping Preliminary Determination
- Washington Focus
- Industry Briefs

Basic Considerations 21
- **Transporting Uranium Fuels**

A well-managed transport system is an important factor in customer satisfaction for nuclear fuel purchases, yet is often overlooked when viewing the front-end of the fuel cycle. With the falling prices in the uranium industry, the margin of profitability on uranium sales is low, making transportation costs an especially significant issue.

Analysis & Commentary 29
- **Nuclear Fuel Reprocessing**

The reprocessing of irradiated nuclear fuel is one of two alternatives currently employed to manage spent fuel discharged from commercial nuclear reactors. Although many countries have selected the reprocessing option for spent fuel, current market conditions and proliferation concerns have caused some countries to re-examine their decisions.

Nuclear Industry Calendar 39

Historical Market Data 40

Government Statistics 47

© NUEXCO 1992

NUEXCO

To Our Readers

CONCORD/NUEXCO is pleased to announce the opening of a new service location in Moscow, Russia. The address of our new office is given below:

CONCORD/NUEXCO
Bolshoy Cherkasskiy pereulok 4
Moscow 103012 Russia
Phone: (7-095) 924-2757
(7-095) 921-2722

Note that the above address should *not* be used for mail service. Please send correspondence to either our Denver or Washington D.C. offices for forwarding. This will ensure your letters or packages are received in a timely manner.

The Moscow office Director of Operations will be Mr. John R. Barter. John recently joined CONCORD from US West Inc., where he had worked since 1980, most recently as Director, Market Implementation for new services. During his tenure with US West, John held positions in finance, federal relations, marketing, and international business development. In 1990, he opened and managed US West's Moscow office and coordinated the company's business in the former Soviet Union, which included the development of a transcontinental fiber optics system and cellular telephone networks for Moscow and St. Petersburg.

CONCORD Vice Chairman Charles H. Peterson, based in Washington D.C., will continue to serve as Area Director of Operations for the Commonwealth of Independent States and other republics of the former Soviet Union. Chuck, along with a number of other CONCORD employees, travel extensively in the CIS and will use the Moscow-based staff, comprised initially of both local and expatriate personnel, in a broad range of CONCORD business activities.

© NUEXCO 1992

Market Values Summary

NUEXCO Market Values	This Report May 31, 1992	Last Report April 30, 1992	12 Months Ago May 31, 1991
EXCHANGE VALUE [1]	**$7.75** / lb equivalent U_3O_8	$7.75	$9.20
UF_6 VALUE [2]	**$23.50** / kg U as UF_6	$23.75	$27.60
LOAN RATE [3]	**3.0%** / annum	3.0%	3.5%
CONVERSION VALUE [4]	**$1.60** / lb U as UF_6	$1.60	$1.50
SWU VALUE [5] **(0.3 % tails assay)**	**$65** / SWU	$67	$54
TRANSACTION VALUE [6]	**$7.85** / lb equivalent U_3O_8	$7.90	$9.30
Transactions	**32**	22	21
Months	**3**	3	3
Millions of Pounds	**7.3**	6.2	5.3

DEFINITIONS

[1] The **Exchange Value** is NUEXCO's judgment of the price at which transactions for significant quantities of natural uranium concentrates could be concluded as of the date indicated.

[2] The **UF_6 Value** is NUEXCO's judgment of the price at which spot and near-term transactions for significant quantities of natural uranium hexafluoride could be concluded as of the date indicated.

[3] The **Loan Rate** is NUEXCO's judgment of the annual interest rate at which uranium loans could be concluded as of the date indicated.

[4] The **Conversion Value** is NUEXCO's judgment of the price at which spot and near-term transactions for significant quantities of conversion services could be concluded in the secondary market as of the date indicated.

[5] The **SWU Value** is NUEXCO's judgment of the price at which spot and near-term transactions for significant quantities of enrichment services could be concluded as of the date indicated.

[6] The **Transaction Value** is a weighted average price of recent natural uranium sales transactions. The calculation is based on prices paid in:

a) Transactions closed within the previous three month period for which delivery is scheduled within one year of the transaction date;

b) At least ten transactions;

c) Transactions involving a sum total of at least 2 million pounds equivalent U_3O_8.

DERIVATIONS AND COMMENTS

- All **Market Values** are expressed in terms of US$.
- All **Market Values** are based on:
  - Data from recently completed transactions.
  - Data from pending transactions.
  - Firm bids to buy or borrow, and firm offers to sell or lend.
  - Prices purchasers or rates borrowers have expressed a willingness to pay, but for which NUEXCO is not aware of firm bids to buy or borrow and prices sellers or rates lenders have expressed a willingness to accept, but for which NUEXCO is not aware of firm offers to sell or lend.
- Prices associated with deliveries under old or renegotiated contracts or other than arm's-length transactions are not included in the determination of these **Market Values**.
- In the determination of prices, NUEXCO does not consider charges for transportation other than that customarily provided by suppliers.
- The prices of services or materials delivered under long-term contracts with primary suppliers are not considered in the determination of the listed values.
- For the **SWU Value**, NUEXCO converts SWU prices at varying tails and product assays to equivalent SWU prices at a tails assay of 0.30 weight-percent (%) ^{235}U and a product assay of 3.0 weight-percent ^{235}U, assuming feed costs corresponding to the NUEXCO **Exchange Value** and **Conversion Value** determined as of the same date.
- In calculating the **Transaction Value**, NUEXCO does not account for the price of uranium delivered in connection with contracts which call for "market price" mechanisms. This exclusion applies particularly to contracts in which delivery prices are expressed as a function of future **Exchange Values** or any other indeterminate variable. Also excluded from the calculation are any other transactions in which the delivery price is defined in such a way that it can not currently be determined.
- The sample time for the **Transaction Value** is extended as necessary to satisfy the minima for the number of transactions and quantity of material. Other currencies are converted to US dollars using conversion rates in effect on or near the transaction date.

© NUEXCO 1992

NUEXCO

MARKET REVIEW

MAY MARKET REVIEW

(as of May 31, 1992)

OVERVIEW

Market activity increased dramatically in May, as numerous discretionary buyers emerged. Twenty near-term transactions involving concentrates, natural UF_6, and enriched UF_6 were reported, totalling almost 6.6 million pounds equivalent U_3O_8. Prices, however, showed little strengthening, for even with the increased demand, several suppliers continued to compete aggressively. The Exchange Value was unchanged at $7.75 per pound U_3O_8, and the UF_6 Value declined slightly, to $23.60 per kgU as UF_6.

Year-to-date market volume now exceeds 17 million pounds equivalent U_3O_8 in 60 near-term transactions (**Table 1**). This is well ahead of the level of market activity at the same time in 1991 (45 transactions totalling 10.5 million pounds) and is comparable to 1990's record-volume pace (46 transactions totalling 19.1 million pounds). To date, much of 1992's volume has resulted from discretionary purchases, while demand to fill actual requirements has been relatively low. In order to sustain the current high pace of market activity, prices will have to remain low enough to motivate discretionary buying.

Table 1
NEAR-TERM URANIUM SALES SUMMARY

	May 1992		Year-to-Date	
	No. of Sales	Volume [1]	No. of Sales	Volume [1]
Concentrates	11	4.9	36	10.0
Natural UF_6	7	1.0	14	3.7
EUP	2	0.7	10	3.3
Total [2]	**20**	**6.6**	**60**	**17.0**

[1] Million pounds equivalent U_3O_8
[2] Due to independent rounding, columns may not equal total.

The Conversion Value remained unchanged at $1.60 per pound U as UF_6; five transactions totalling more than 3.8 million pounds U were reported. The Loan Rate also remained unchanged at 3.0 percent per annum, with no loans reported in May.

The SWU Value dropped two dollars, to $65 per SWU, as demand remained low compared to supply. Five SWU and enriched uranium product (EUP) sales totalling more than 200 thousand SWU were reported.

On May 29, the Department of Commerce released its preliminary determination on the anti-dumping petition filed against the former Soviet Union. The decision announced a preliminary dumping margin of 115.82 percent on uranium from the six newly independent uranium-producing republics. Due to the timing of this release, the determination had no effect on the May 31 Market Values. The final determination normally is released by the Commerce Department 75 days after the release of its preliminary determination, unless additional extensions are granted. A more detailed account of the preliminary determination and the anti-dumping petition can be found on page 14 of this Report.

NATURAL URANIUM AND CONVERSION

The May 31 **Exchange Value** remained at **$7.75** per pound U_3O_8. Early in the month, spot market prices dipped slightly, as several suppliers competed aggressively for sales. In the face of new discretionary demand in the latter half of May, prices firmed again, but an abundance of supply prevented any net price rise by month end. The Commerce Department's preliminary determination on the anti-dumping petition was not released until the end of the month, therefore the Exchange Value did not have time to reflect the market's reaction to this announcement.

© NUEXCO 1992

However, the results of this determination had been anticipated for weeks, and few market participants were surprised by the specific outcome. Consequently, the market impact has been minimal, and as far as can be determined, neither buyers nor sellers have altered their market plans.

Eleven concentrates sales were reported in May, totalling over 4.9 million pounds equivalent U_3O_8. Nearly all of these sales occurred at price levels at or near the May 31 Exchange Value. The total volume of concentrates sold was substantial, but more than half the total can be attributed to a large sale by a producer that occurred earlier this year. Producers, intermediaries, and utilities all bought material, with producers making at least seven of the eleven purchases. Roughly half the buyers were US-based companies, as were more than half the sellers. Sellers included intermediaries, producers, and unidentified firms.

* * *

Intense competition for limited UF_6 demand led to a $0.15 decrease in the **$UF_6$ Value**, to **$23.60** per kgU as UF_6. Supply of UF_6 is currently high, and sellers aggressively marketed these supplies during the month, resulting in UF_6 selling at an $0.18 discount from the sum of the values of its components—concentrates and conversion.

Table 2
NEAR-TERM SUPPLY/DEMAND SUMMARY

	Active Supply[1]	Active Demand[1]
• Uranium (thousand lbs equivalent U_3O_8)	7,640	1,510
• Supply/Demand Ratio:	5.1	
• Loan (thousand lbs equivalent U_3O_8)	6,370	1,250
• Conversion (thousand lbs U as UF_6)	3,260	620
• SWU (thousand SWUs)	780	5

[1] Supply and Demand tables in the Market Review section of this Report provide details for each category.

Seven natural UF_6 sales were reported in which intermediaries sold almost one million pounds equivalent U_3O_8 at prices at or near the May 31 UF_6 Value. More than half the buyers were US utilities.

* * *

The **long-term uranium market** was active as well: five utilities and a producer purchased a total of almost 4.5 million pounds equivalent U_3O_8 in six transactions for delivery during the period 1993 through 2001. At least four of the contracts utilized base-escalated pricing terms; the others used prices related to spot market indicators.

* * *

The **Transaction Value** decreased $0.05, to **$7.85** per pound U_3O_8, based on 32 transactions over three months involving 7.3 million pounds equivalent U_3O_8. The inclusion of May's numerous lower-priced sales led to the decline.

* * *

Despite the low prices and the market's anticipation of the preliminary determination on the anti-dumping petition, **active uranium supply** increased by more than 2.5 million pounds, to **7.6** million pounds equivalent U_3O_8. **Active uranium demand** also increased, but only by 800 thousand pounds, to **1.5** million pounds equivalent U_3O_8. The **supply/demand ratio** decreased to **5.1**.

* * *

The **Loan Rate** remained unchanged at **3.0** percent per annum. No loans were reported during May.

* * *

Although the **Conversion Value** was unchanged at **$1.60** per pound U as UF_6, transaction prices occurred over a wide range. While two sales were concluded near the prevailing Conversion Value, others transpired both above and below this value. In general, prices tended to be higher in Europe and lower in the USA. Some factors that may

© NUEXCO 1992

have contributed to the higher European conversion prices were higher levels of demand and the fact that the most active sellers were primary converters with little excess capacity. In contrast, prices were lower in the USA, where demand was not as strong, primary converters had excess capacity, and several traders were active sellers in the market. This geographic price dichotomy between Europe and the USA is a result of the combination of these factors.

Five transactions were reported, totalling more than 3.8 million pounds U of conversion services for delivery in 1992 and 1993. Buyers were utilities and intermediaries, and sellers were primary converters and intermediaries.

ENRICHMENT SERVICES AND ENRICHED URANIUM PRODUCT

The **SWU Value** decreased two dollars, to **$65** per SWU, as demand for enrichment services on the secondary market remained very low relative to available supply (**Table 2**). Five enrichment transactions were reported: three utilities purchased small quantities of SWU for delivery later this year, and two other buyers made EUP purchases for third quarter delivery, containing a total of almost 700 thousand pounds equivalent U_3O_8 and more than 100 thousand SWU.

Table 3
ENRICHMENT PRICES
(May 31, 1992)

Prices	This Month Report 286	Last Month Report 285	12 Months Ago Report 274
NUEXCO SWU Value ($US per SWU)	65	67	54
US DOE SWU prices: ($US per SWU)			
USC	121.50[1]	121.50[1]	117.85[2]
AFC	153.00[3]	153.00[3]	153.00[3]
Requirements	157.00[3]	157.00[3]	157.00[3]
Incentive Price (IP2)	104.67[4]	104.67[4]	100.68[5]
Calculated worth of enriched UF_6[6]: ($US per KgU as UF_6)			
2.0 % ^{235}U	209	212	205
2.5 % ^{235}U	292	297	284
3.0 % ^{235}U	379	386	365
3.5 % ^{235}U	467	476	447
4.0 % ^{235}U	557	568	531
4.5 % ^{235}U	648	660	616

[1] Effective 10/1/91.
[2] Effective 10/1/89 to 9/30/91.
[3] Effective since 10/1/84.
[4] Provisional IP2 for FY92: Effective 10/1/91 to 9/30/92, for up to 30% of annual requirements.
[5] IP2: Effective 10/1/90 to 9/30/91, for up to 30% of annual requirements.
[6] Calculated using the NUEXCO Exchange Value, Conversion Value, SWU Value and 0.30 % ^{235}U tails assay.

© NUEXCO 1992

RECENT TRANSACTIONS

Uranium Sales [1]

NUEXCO Transaction Number	Delivery Period	Approximate Quantity (thousand pounds equivalent U_3O_8)	Price Within Percentage Range [2] of Current Exchange or UF_6 Value	Buyer	Seller	Remarks
5399	1992	3,001-6,000	R	R	Producer	Occurred earlier in 1992
5425	1992	Less Than 50	R	Intermediary	Intermediary	UF_6
5427	1993-1995	1,001-3,000	See Remarks	Utility	Intermediary	Price Related to Market
5431	1992	101-300	98-102	Utility	Intermediary	UF_6
5433	1992	301-600	98-102	Utility	Intermediary	
5434	1992	101-300	98-102	Utility	Intermediary	UF_6
5436	1992	101-300	98-102	Producer	Intermediary	
5437	1992	101-300	98-102	Producer	Intermediary	
5438	1992	50-100	98-102	Producer	Intermediary	
5439	1992	Less Than 50	98-102	Producer	Intermediary	
5440	1992	101-300	98-102	Producer	R	
5442	1993-1996	301-600	See remarks	Utility	Intermediary	Base Escalated
5443	1992	50-100	98-102	Utility	Intermediary	UF_6
5444	1993	101-300	98-102	Utility	R	

R means that NUEXCO either does not know, or that NUEXCO has restricted that information to protect client or source confidentiality.

[1] Transactions listed are not limited to those in which NUEXCO was involved, but also include others of which NUEXCO is aware. NUEXCO may delay reporting some transactions in order to protect proprietary information.

[2] The ranges *Below 90, 90-97, 98-102, 103-110, Above 110*, represent percentages (rounded to whole numbers) of the appropriate current Exchange Value or UF_6 Value. The endpoints of each range are included within that range.

© NUEXCO 1992

NUEXCO

MARKET REVIEW

RECENT TRANSACTIONS

Uranium Sales[1] *(continued)*

NUEXCO Transaction Number	Delivery Period	Approximate Quantity (thousand pounds equivalent U_3O_8)	Price Within Percentage Range[2] of Current Exchange or UF_6 Value	Buyer	Seller	Remarks
5446	1992	101-300	98-102	Utility	Intermediary	UF_6
5447	1992	101-300	98-102	Intermediary	Intermediary	
5448A	1992	Less Than 50	See Remarks	Fabricator	Intermediary	Contained in EUP
5449	1992	Less Than 50	98-102	R	Intermediary	UF_6
5450	1992	101-300	98-102	Intermediary	Intermediary	UF_6
5451	1996-2000	1,001-3,000	See Remarks	Utility	Producer	Price Related to Market
5453	1992	Less Than 50	98-102	Producer	Intermediary	
5454	1992	Less Than 50	98-102	Producer	Intermediary	
5455	1993	101-300	See Remarks	Producer	Intermediary	Base Escalated
5457	1993-2001	1,001-3,000	See Remarks	Utility	Intermediary	UF_6 – Base Escalated
5458	1993-2001	301-600	See Remarks	Utility	Intermediary	Base Escalated
5461A	1992	601-1,000	See Remarks	Utility	Intermediary	Contained in EUP

R means that NUEXCO either does not know, or that NUEXCO has restricted that information to protect client or source confidentiality.

[1] Transactions listed are not limited to those in which NUEXCO was involved, but also include others of which NUEXCO is aware. NUEXCO may delay reporting some transactions in order to protect proprietary information.

[2] The ranges *Below 90, 90-97, 98-102, 103-110, Above 110*, represent percentages (rounded to whole numbers) of the appropriate current Exchange Value or UF_6 Value. The endpoints of each range are included within that range.

© NUEXCO 1992

RECENT TRANSACTIONS

Natural Uranium Loans[1]

NUEXCO Transaction Number	Delivery Period	Approximate Quantity (thousand pounds equivalent U_3O_8)	Price Within Percentage Range[2] of Current Loan Rate	Borrower	Lender	Remarks
No Natural Uranium Loans are reported						

Conversion Sales[1]

NUEXCO Transaction Number	Delivery Period	Approximate Quantity (thousand pounds of U equivalent)	Price Within Percentage Range[2] of Current Conversion Value	Buyer	Seller	Remarks
5428	1992	50-100	98-102	Utility	R	
5445	1992	301-600	98-102	Intermediary	Intermediary	
5452	1992	301-600	Above 110	Intermediary	Converter	
5456	1992-1993	1,001-3,000	Above 110	Intermediary	Converter	
5460	1992	101-300	Below 90	Utility	R	

Enrichment Sales[1]

NUEXCO Transaction Number	Delivery Period	Approximate Quantity[3] (thousand SWU)	Price Within Percentage Range[2] of Current SWU Value[4]	Buyer	Seller	Remarks
5432	1992	Less Than 50	98-102	Utility	Intermediary	
5435	1992	Less Than 50	103-110	Utility	Intermediary	
5448B	1992	Less Than 50	See Remarks	Fabricator	Intermediary	Contained in EUP
5459	1992	Less Than 50	98-102	Utility	R	
5461B	1992	101-300	See Remarks	Utility	Intermediary	Contained in EUP

R means that NUEXCO either does not know, or that NUEXCO has restricted that information to protect client or source confidentiality.

[1] Transactions listed are not limited to those in which NUEXCO was involved, but also include others of which NUEXCO is aware. NUEXCO may delay reporting some transactions in order to protect proprietary information.

[2] The ranges *Below 90, 90-97, 98-102, 103-110, Above 110,* represent percentages (rounded to whole numbers) of the appropriate current Market Value. The endpoints of each range are included within that range.

[3] If tails assay is unknown or unspecified, NUEXCO's calculation of SWU quantity assumes 0.30% tails assay.

[4] Prices are usually normalized to 0.30% tails assay. When prices and SWU values are expressed as discounts from a reference price (e.g., X dollars less than DOE's USEC base price at time of delivery), the percentage price range is based on the discounted prices, not on the reference price.

© NUEXCO 1992

NUEXCO

MARKET REVIEW

SUPPLY AND DEMAND

Uranium Supply

NUEXCO Project Number	Quantity (Thousand Pounds equivalent U_3O_8) Spot or Near-term [1]	Intermediate or Long-term [2]	Delivery Period	Remarks
AVAILABLE FOR SALE:				
ACTIVE				
91-1505*	1,250	—	1992	
91-1507	500	—	1992	
91-1511*	1,825	—	1992	UF_6/UF_6c
91-1512*	1,050	—	1992	UF_6
92-1128*	1,170	—	1992	
92-1160*	700	—	1992	
92-1501A	645	—	1992	UF_6c
92-1509	500	—	1992	UF_6
91-1268	—	600 per year	1992-1999	
92-1129*	—	465 per year	1993-1999	
TOTAL	**7,640**			
INACTIVE	**2,805**			
AVAILABLE TO LOAN:				
ACTIVE				
92-1072	1,600	—	1992	UF_6
92-1074	1,000	—	1992	
92-1075	500	—	1992	
92-1077	180	—	1992	UF_6
92-1114	390	—	1992	UF_6
92-1161*	700	—	1992	
92-1503	2,000	—	1992	
TOTAL	**6,370**			
INACTIVE	**1,600**			

* New or revised since last month.

[1] For delivery within one year, measured from the date of this Report. This category excludes material deliverable within one year under other than spot or near-term contracts.

[2] For delivery beyond one year, measured from the date of this Report.

Active Projects reclassified as Inactive since last month: 92-1008, 92-1119

Active Projects removed since last month: 91-1506

© NUEXCO 1992

SUPPLY AND DEMAND

Uranium Demand

NUEXCO Project Number	Quantity (Thousand Pounds equivalent U_3O_8) Spot or Near-term [1]	Intermediate or Long-term [2]	Delivery Period	Remarks
INQUIRIES TO PURCHASE:				
ACTIVE				
92-1127*	25	—	1992	U_3O_8/UF_6
92-1140*	200	—	1992	
92-1144*	390	—	1992	U_3O_8/UF_6
92-1152A*	15	—	1993	UF_6e
92-1153*	500	—	1992	U_3O_8/UF_6
92-1158*	380	—	1992	
91-1184	—	350 per year	1993-1997	
91-1197	—	2,210	1992-1997	U_3O_8/UF_6
91-1267*	—	915	1993	UF_6
91-1290	—	310 per year	1995-1999	U_3O_8/UF_6
92-1015	—	1,300 per year	1995-2004	
92-1032	—	200 per year	1996-1998	U_3O_8/UF_6
TOTAL	**1,510**			
INACTIVE	**1,560**			
INQUIRIES TO BORROW:				
ACTIVE				
92-1505	500	—	1992	
92-1511*	750	—	1992	
TOTAL	**1,250**			
INACTIVE	*None reported*			

* New or revised since last month.

[1] For delivery within one year, measured from the date of this Report. This category excludes material deliverable within one year under other than spot or near-term contracts.

[2] For delivery beyond one year, measured from the date of this Report.

Active Projects reclassified as Inactive since last month: *none*

Active Projects removed since last month: 91-1283, 91-1294, 92-1064, 92-1110, 92-1113, 92-1120

© NUEXCO 1992

NUEXCO

MARKET REVIEW

SUPPLY AND DEMAND

Conversion Supply and Demand

NUEXCO Project Number	Quantity (Thousand Pounds U as UF_6) Within 3 Years [1]	Beyond 3 Years [2]	Delivery Period	Remarks
AVAILABLE FOR SALE:				
ACTIVE				
91-1500*	400	—	1992	
91-1501	1,100	—	1992	
92-1154*	660	—	1992	
92-1507	1,100	—	1992	
TOTAL	**3,260**			
INACTIVE	*None reported*			
INQUIRIES TO PURCHASE:				
ACTIVE				
91-1275*	620	—	1992-1993	
TOTAL	**620**			
INACTIVE	**130**			

* New or revised since last month.
[1] Measured from the date of this Report.
Active Projects reclassified as Inactive since last month: *none*
Active Projects removed since last month: 92-1068, 92-1107, 92-1111, 92-1508

© NUEXCO 1992

SUPPLY AND DEMAND

SWU Supply and Demand

NUEXCO Project Number	Quantity (Thousand Pounds equivalent U_3O_8) Spot or Near-term [1]	Intermediate or Long-term [2]	Delivery Period	Remarks
AVAILABLE FOR SALE:				
ACTIVE				
91-1509	200	—	1992	
91-1515	200	—	1992	
92-1501B	130	—	1992	UF_6e
92-1124*	250	250 per year	1992-1994	
TOTAL	**780**			
INACTIVE	*None reported*			
INQUIRIES TO PURCHASE:				
ACTIVE				
ACTIVE				
92-1152B*	5	—	1993	UF_6e
90-1196	—	60 per year	1995 on	
91-1152	—	2,700	1995-2001	
92-1016	—	170 per year	1996-2006	
TOTAL	**5**			
INACTIVE	**140**			—

* New or revised since last month.

[1] For delivery within one year, measured from the date of this Report. This category excludes material deliverable within one year under other than spot or near-term contracts.

[2] For delivery beyond one year, measured from the date of this Report.

Active Projects reclassified as Inactive since last month: 91-1142

Active Projects removed since last month: 91-1171, 91-1250, 92-1024, 92-1058, 92-1079, 92-1096B

© NUEXCO 1992

NUEXCO

MARKET REVIEW

MARKET VALUES EXPRESSED IN SELECTED CURRENCIES[1]

Australia to Hungary

	Australia (dollar)	Belgium (franc)	Canada (dollar)	China (renminbi)	CSFR (koruna)	EC (ecu)	Finland (markka)	France (franc)	Germany (mark)	Hungary (forint)
EXCHANGE VALUE										
per pound equivalent U_3O_8 as Concentrates										
This Month (May 31, 1992)	**10.24**	**256.28**	**9.32**	**42.59**	**221.73**	**6.06**	**33.81**	**41.79**	**12.46**	**610.08**
Last Month (Apr 30, 1992)	10.23	262.98	9.24	42.77	219.94	6.23	34.75	43.11	12.78	610.16
12 Months Ago (May 31, 1991)	12.09	329.63	10.53	48.88	— · —	7.72	38.11	54.40	16.03	— · —
per kg U as Concentrates										
This Month (May 31, 1992)	**26.61**	**666.28**	**24.23**	**110.71**	**576.44**	**15.76**	**87.89**	**108.66**	**32.39**	**1,586**
Last Month (Apr 30, 1992)	26.61	683.69	24.02	111.20	571.81	16.20	90.36	112.08	33.23	1,586
12 Months Ago (May 31 1991)	31.43	856.97	27.38	127.06	— · —	20.06	99.07	141.43	41.66	— · —
UF_6 VALUE										
per kg U as UF_6										
This Month (May 31, 1992)	**31.17**	**780.42**	**28.38**	**129.68**	**675.20**	**18.46**	**102.94**	**127.27**	**37.94**	**1,858**
Last Month (Apr 30, 1992)	31.36	805.90	28.32	131.08	674.02	19.09	106.51	132.12	39.17	1,870
12 Months Ago (May 31, 1991)	36.27	988.89	31.59	146.63	— · —	23.15	114.32	163.20	48.08	— · —
TRANSACTION VALUE										
per pound equivalent U_3O_8 as Concentrates										
This Month (May 31, 1992)	**10.37**	**259.59**	**9.44**	**43.14**	**224.59**	**6.14**	**34.24**	**42.33**	**12.62**	**617.95**
Last Month (Apr 30, 1992)	10.43	268.07	9.42	43.60	224.20	6.35	35.43	43.95	13.03	621.97
12 Months Ago (May 31, 1991)	12.22	333.21	10.64	49.41	— · —	7.80	38.52	54.99	16.20	— · —
per kg U as Concentrates										
This Month (May 31, 1992)	**26.95**	**674.88**	**24.54**	**112.14**	**583.88**	**15.96**	**89.02**	**110.06**	**32.81**	**1,607**
Last Month (Apr 30, 1992)	27.12	696.92	24.49	113.35	582.88	16.51	92.10	114.25	33.87	1,617
12 Months Ago (May 31, 1991)	31.77	866.28	27.67	128.45	— · —	20.28	100.14	142.96	42.11	— · —
CONVERSION VALUE										
per pound U as UF_6										
This Month (May 31, 1992)	**2.11**	**52.91**	**1.92**	**8.79**	**45.78**	**1.25**	**6.98**	**8.63**	**2.57**	**125.95**
Last Month (Apr 30, 1992)	2.11	54.29	1.91	8.83	45.41	1.29	7.18	8.90	2.64	125.97
12 Months Ago (May 31, 1991)	1.97	53.74	1.72	7.97	— · —	1.26	6.21	8.87	2.61	— · —
per kg U as UF_6										
This Month (May 31, 1992)	**4.66**	**116.65**	**4.24**	**19.38**	**100.92**	**2.76**	**15.39**	**19.02**	**5.67**	**277.68**
Last Month (Apr 30, 1992)	4.66	119.69	4.21	19.47	100.11	2.84	15.82	19.62	5.82	277.71
12 Months Ago (May 31, 1991)	4.35	118.49	3.78	17.57	— · —	2.77	13.70	19.55	5.76	— · —
SWU VALUE										
per SWU at 0.30% ^{235}U Tails Assay										
This Month (May 31, 1992)	**85.84**	**2,149**	**78.17**	**357.17**	**1,860**	**50.83**	**283.53**	**350.54**	**104.48**	**5,117**
Last Month (Apr 30, 1992)	88.47	2,274	79.89	369.77	1,901	53.85	300.46	372.72	110.49	5,275
12 Months Ago (May 31, 1991)	70.96	1,935	61.81	286.88	— · —	45.28	223.49	319.30	94.06	— · —

[1] Calculated using currency exchange rates for the last business day of the month, as published in *The Wall Street Journal*.

© NUEXCO 1992

MARKET VALUES EXPRESSED IN SELECTED CURRENCIES[1]

Italy to United States	Italy (lira)	Japan (yen)	Netherlands (guilder)	S. Africa (comm. rand)	S. Korea (won)	Spain (peseta)	Sweden (krona)	Switzerland (franc)	Taiwan (dollar)	UK (pound)	USA (dollar)
EXCHANGE VALUE											
per pound equivalent U_3O_8 as Concentrates											
This Month (May 31, 1992)	**9,381**	**989.28**	**14.03**	**21.94**	**6,194**	**776.79**	**44.88**	**11.29**	**190.89**	**4.24**	**7.75**
Last Month (Apr 30, 1992)	9,607	1,033	14.38	22.28	6,159	801.70	46.13	11.72	193.35	4.36	7.75
12 Months Ago (May 31, 1991)	11,891	1,272	18.06	25.92	6,664	992.23	57.46	13.65	247.48	5.42	9.20
per kg U as Concentrates											
This Month (May 31, 1992)	**24,390**	**2,572**	**36.47**	**57.03**	**16,102**	**2,019**	**116.67**	**29.35**	**496.28**	**11.01**	**20.15**
Last Month (Apr 30, 1992)	24,976	2,685	37.37	57.93	16,011	2,084	119.93	30.46	502.66	11.34	20.15
12 Months Ago (May 31, 1991)	30,914	3,307	46.96	67.37	17,326	2,580	149.39	35.48	643.39	14.09	23.92
UF_6 VALUE											
per kg U as UF_6											
This Month (May 31, 1992)	**28,568**	**3,013**	**42.72**	**66.80**	**18,860**	**2,365**	**136.65**	**34.37**	**581.30**	**12.90**	**23.60**
Last Month (Apr 30, 1992)	29,441	3,165	44.05	68.29	18,873	2,457	141.37	35.91	592.52	13.37	23.75
12 Months Ago (May 31, 1991)	35,673	3,816	54.19	77.75	19,993	2,977	172.39	40.94	742.43	16.25	27.60
TRANSACTION VALUE											
per pound equivalent U_3O_8 as Concentrates											
This Month (May 31, 1992)	**9,502**	**1,002**	**14.21**	**22.22**	**6,273**	**786.81**	**45.45**	**11.43**	**193.35**	**4.29**	**7.85**
Last Month (Apr 30, 1992)	9,793	1,053	14.65	22.71	6,278	817.21	47.02	11.94	197.09	4.45	7.90
12 Months Ago (May 31, 1991)	12,020	1,286	18.26	26.20	6,737	1,003	58.09	13.80	250.17	5.48	9.30
per kg U as Concentrates											
This Month (May 31, 1992)	**24,704**	**2,605**	**36.94**	**57.76**	**16,310**	**2,046**	**118.17**	**29.72**	**502.68**	**11.16**	**20.41**
Last Month (Apr 30, 1992)	25,460	2,737	38.10	59.05	16,321	2,125	122.25	31.05	512.39	11.56	20.54
12 Months Ago (May 31, 1991)	31,250	3,343	47.47	68.11	17,514	2,608	151.02	35.87	650.38	14.24	24.18
CONVERSION VALUE											
per pound U as UF_6											
This Month (May 31, 1992)	**1,937**	**204.24**	**2.90**	**4.53**	**1,279**	**160.37**	**9.26**	**2.33**	**39.41**	**0.87**	**1.60**
Last Month (Apr 30, 1992)	1,983	213.19	2.97	4.60	1,271	165.51	9.52	2.42	39.92	0.90	1.60
12 Months Ago (May 31, 1991)	1,939	207.38	2.95	4.23	1,087	161.78	9.37	2.23	40.35	0.88	1.50
per kg U as UF_6											
This Month (May 31, 1992)	**4,270**	**450.27**	**6.39**	**9.98**	**2,819**	**353.55**	**20.42**	**5.14**	**86.88**	**1.93**	**3.53**
Last Month (Apr 30, 1992)	4,373	470.01	6.54	10.14	2,803	364.89	21.00	5.33	88.00	1.99	3.53
12 Months Ago (May 31, 1991)	4,274	457.20	6.49	9.32	2,395	356.66	20.66	4.91	88.96	1.95	3.31
SWU VALUE											
per SWU at 0.30% ^{235}U Tails Assay											
This Month (May 31, 1992)	**78,683**	**8,297**	**117.67**	**183.98**	**51,946**	**6,515**	**376.38**	**94.67**	**1,601**	**35.53**	**65.00**
Last Month (Apr 30, 1992)	83,054	8,927	124.28	192.64	53,242	6,931	398.81	101.30	1,672	37.72	67.00
12 Months Ago (May 31, 1991)	69,794	7,466	106.03	152.11	39,116	5,824	337.29	80.11	1,453	31.80	54.00

[1] Calculated using currency exchange rates for the last business day of the month, as published in *The Wall Street Journal*.

© NUEXCO 1992

RECENT DEVELOPMENTS

USA

On May 29, the Department of Commerce (DOC) issued a preliminary determination in its anti-dumping investigation regarding uranium from the former Soviet Union. Based on data submitted by the petitioners and disregarding data submitted by the respondents—including Techsnabexport, Global Nuclear Services and Supply Ltd., and NUEXCO—DOC determined that the countries of Kazakhstan, Kyrgyzstan, Russia, Tajikistan, Ukraine, and Uzbekistan had sold uranium in the USA at less than fair value, and accordingly, estimated a preliminary dumping margin of 115.82 percent. The Department also found that the six other former republics have not produced, exported, or stockpiled any uranium and therefore may be excused from the petition.

Under the special procedures applicable to non-market economies, the Commerce Department constructed a foreign market value (FMV) for the estimation of uranium production costs, based on a surrogate country analysis using Portugese electricity costs, Namibian labor costs, and average Canadian mining efficiency. Enrichment costs were estimated using the operating costs of British Nuclear Fuels plc and Portugese electricity costs. DOC calculated that the FMV of uranium was US$26.31 per pound U_3O_8 and that the FMV for EUP was US$1,256.43 per kgU (based on a US$141 per SWU enrichment cost). These costs were compared to an arbitrary average US value, and then averaged together to determine the artificially precise preliminary dumping margin of 115.82 percent.

The petition now enters a two-phased process, with DOC continuing toward its final determination now scheduled for August 11, and the International Trade Commission (ITC) beginning the second phase of its investigation into whether the domestic industry has been injured. DOC has scheduled a public hearing for August 3; ITC is scheduled to make its final ruling 45 days after the final DOC ruling. Only if ITC makes an affirmative final determination that the domestic industry has been injured will DOC issue an anti-dumping duty order. The timeline in the following table shows the historical and projected dates of key events of the investigation.

In April, Techsnabexport and the republics of Ukraine and Tajikistan sought a preliminary injunction from the Court of International Trade to end the investigation. While the Court did not grant the preliminary injunction, the Court did retain jurisdiction, thus indicating its willingness to continue the examination of the legality of the Commerce Department's decision. The Court will be receiving briefs from all interested parties in June and July. If the Court agrees that the continuation of the DOC investigation is illegal, the Court could order that the case be terminated.

© NUEXCO 1992

Anti-Dumping Petition Timeline

1991

November 8 The Ad Hoc Committee of Domestic Uranium Producers, which consists of eleven mining and milling companies, and the Oil, Chemical and Atomic Workers International Union, filed a petition on behalf of the US uranium industry, claiming injury from imports of Soviet uranium.

December 23 The International Trade Commission, based on its preliminary investigation, annouced its decision "that there is a reasonable indication" that the US uranium industry is being materially injured by imports of uranium from the Soviet Union that "allegedly are sold at less than fair value".

1992

March 25 Despite the request by some respondents that the proceeding be terminated as the result of the dissolution of the Soviet Union, the Commerce Department determined that the investigation should continue against the republics of the former Soviet Union.

April 9 & 13 Before the Court of International Trade, Ukraine, Tajikistan, and Techsnabexport sought to enjoin the continuation of the DOC investigation on the grounds that the dissolution of the Soviet Union rendered the petition invalidly filed. They also requested that the Court terminate the investigation. (The Russian Federation filed a similar action on June 9.)

May 25 The Court did not terminate the investigation as requested by the republics, but retained jurisdiction.

May 29 The Commerce Department issued its preliminary determination that uranium had been sold at less than fair value by Kazakhstan, Kyrgyzstan, Russia, Tajikistan, Ukraine, and Uzbekistan. The result of the findings is an estimated dumping duty of 115.82 percent to be deposited on uranium imported from the republics. The Commerce Department determined that no sales at less than fair value had been made by Armenia, Azerbaijan, Byelarus, Georgia, Moldova, and Turkmenistan, republics which produce no uranium.

August 3 Interested parties may comment at a public hearing on the Commerce Department's preliminary determination.

August 11 The Commerce Department is scheduled to issue its final determination, but the date can be extended up to 60 days (October 9). If the final determination of the Commerce Department is affirmative, the International Trade Commission will have 45 days to decide whether the imports have materially injured or threaten injury to the US uranium industry. If the International Trade Commission in its final determination finds injury or threat of injury, the Commerce Department will issue an order instructing the US Customs Service to collect the anti-dumping duties.

© NUEXCO 1992

RECENT DEVELOPMENTS

WASHINGTON FOCUS

by Linda L. Gunter

On May 27, the House of Representatives approved the Comprehensive National Energy Policy bill HR 776 by a vote of 381-37. With titles on improving energy efficiency and conservation, filling the strategic petroleum reserve, as well as important support for nuclear licensing reform, uranium enrichment restructuring, low-level waste deregulation, and allowing the Department of Energy (DOE) to move forward on Yucca Mountain spent fuel repository characterization, this major legislation will, if enacted, go a long way toward creating an energy policy for the USA.

Rules Committee Hearing

◇ The House Rules Committee heard more than 50 congressmen on May 19, to determine how the full House would consider the Energy bill. Nine committees had jurisdiction over some or all of the bill, and it was the Rules Committee's job to determine what text would be considered by the full House and how many amendments would be allowed. Eventually it was determined that the Energy & Commerce committee had the most jurisdiction, followed by the Interior Committee. Consequently, the base text was mostly the version of HR 776 marked up by the Energy & Commerce committee, with some titles of the bill (such as nuclear provisions) adopted from other committees because of negotiations between Energy & Commerce Committee chairman John Dingell (D-MI) and the other respective committee chairs.

Enrichment Title

◇ The Rules Committee's determination was very important for the enrichment title of the energy bill because four committees (Energy & Commerce; Interior; Science, Space & Technology; and Ways & Means) had joint jurisdiction. The most controversial aspect of the enrichment section of the bill was the funding of decontamination and decommissioning (D&D). Ultimately a compromise was reached, whereby the Energy & Commerce version of enrichment restructuring was melded with the Interior version, but included some aspects of the Ways & Means Committee language on D&D. A side-by-side comparison of the Senate and the House versions follow.

The consensus seems to be that the enrichment bill as passed by the House will not create a competitive corporation. Because this version is substantially different from the Senate version, which has not had close scrutiny for two years, current thinking among Washington lobbyists is that the entire title will have to be rewritten in the joint House-Senate conference committee, which is expected to begin its work in late June to reconcile the differences between the two versions.

Energy Bill Nuclear Provisions

◇ The Energy bill includes other areas of interest to the nuclear industry. By a vote of 254-160, the House passed the Clement/Barton amendment, which ensures nuclear licensing reform and thereby facilitates the industry activities surrounding the next nuclear plant order. The language endorses the Nuclear Regulatory Commission's regulatory changes made last year that deter intervenors from forcing a second public hearing prior to start of the completed reactor. The House also passed, by voice vote, a title allowing DOE to move forward with characterization of the spent fuel repository at Yucca Mountain, despite the state of Nevada's lack of cooperation.

One area of concern to uranium mining companies is an amendment offered by Rep. Robert Matsui (D-CA) during the Ways & Means Committee markup,

© NUEXCO 1992

which provides a tax credit for wind and solar companies, while removing the tax depreciation allowance from uranium, lead, mercury, and asbestos companies. Rep. Matsui's amendment was accepted as original text for purposes of House consideration of the bill. Although the Senate bill does not have this language, tax provisions constitutionally must originate in the House and therefore the House conferees (in a House-Senate conference) will have greater say about whether this provision is retained. Reps. Phil Sharp (D-IN) and John Dingell could have helped the uranium industry remove these provisions; however, their unwillingness to do so was caused by their dismay at the neutral position of the Uranium Producers of America on the uranium enrichment restructuring title.

Comparison of Uranium Enrichment Restructuring Legislation

Senate Bill S 2166	*House Bill HR 776*
I. GOVERNMENT CORPORATION	
United States Enrichment Corporation (USEC)	***Uranium Enrichment Corporation***
Capital Structure:	**Capital Structure:**
• Production facilities, except Oak Ridge*, inventory, and patents transfer to the Corporation. Liabilities chargeable to transferred unexpended balances of appropriations become liabilities of Corporation.	• Current contracts transfer to Corporation. May lease GDPs, but not HEU facilities. Privatization process is different: OMB, through secret minimum bid, offers assets for sale in competitive bidding situation.
• Capital stock wholly owned by US equal to book value of assets transferred to Corporation. Dividends on Capital stock payable to Treasury unless there is an overriding need to retain earnings.	• Can issue bonds but cannot use money to construct an enrichment facility. Bonds are not guaranteed by the US government.
• $364 million initial debt payable within 20 years.	• $364 million is loaned to the Corporation from the existing Uranium Enrichment Special Account, and must be repaid with interest within 20 years. All other money in the Special Fund is transferred to Treasury.
• Capital stock and initial debt constitute sole recovery of previously unrecovered costs.	
• Authorized to issue $2.5 billion in public debt, pledged by revenues. Not guaranteed by US government and no Federal Financing Bank borrowing.	
Environmental/Occupational Safety Laws:	**Environmental/Occupational Safety Laws:**
• Four years after enactment, USEC subject to federal environmental laws and OSHA, to the same extent as private corporations.	• USEC subject to federal, state, interstate, and local environmental laws, and OSHA, to the same extent as private corporations.
Management/Board of Directors:	**Management/Board of Directors:**
• Five members appointed by the President, with the advice and consent of the Senate, for five-year terms, with one member a former electric utility manager.	• Similar, except board has eleven members.
• Corporation managed by an administrator appointed by the President and approved by the Senate.	• Conflict of interest provision precludes utilities from membership.
• Annual performance report to Administrator (CEO) and Congress.	• Corporation managed by administrator appointed by Board.

* In S 210, Oak Ridge transfers after 2000 when government decides it can be decommissioned.

© NUEXCO 1992

NUEXCO

RECENT DEVELOPMENTS

Comparison of Uranium Enrichment Restructuring Legislation *(continued)*

Senate Bill S 2166	*House Bill HR 776*
Pricing: • Commercial pricing set to recover costs over the long term, repay initial debt, recover commercial share of D&D and remedial actions, and generate profit. • Government pricing set annually to recover costs including depreciation, government share of D&D, and remedial actions, but excluding repayment of the initial debt and profit. Government pricing for LEU shall not exceed the average base charge paid by commercial customers.	**Pricing:** • Prices charged to DOE shall recover costs on a yearly basis for providing products, materials and services. The prices are intended to cover depreciation, interest, D&D, and reasonable profits. No specific language about pricing to commercial customer.
Federal Tax Status: • No state or local taxes; payments in lieu of state and local taxes in a comparable amount to similar private industries, excluding any amount that private industry would pay as a tax on net income. • Bill is silent on federal taxation.	**Federal Tax Status:** • No federal taxes; state or local payments in lieu of taxes in comparable amount to similar private industries. • Payments do not begin until 1998.
NRC Licensing Requirements: • Corporation initially exempt from NRC licensing with respect to existing GDPs; NRC to promulgate regulations within 2 years; Corporation must apply for license within one year. Bill is silent on licensing for new facilities and for R&D.	**NRC Licensing Requirements:** • AVLIS can be licensed under production and utilization regulations. Operation of GDPs must be regulated by NRC in consultation with EPA and DOE. If the Corporation leases the GDPs, NRC must establish certification process so the Corporation is in compliance with regulation.
II. DECONTAMINATION AND DECOMMISSIONING	
• For LEU, the cost for D&D to be recovered from commercial customers is a ratio of the amount of SWU purchased by the customers to the total amount produced over the life of the property.	• D&D fund of $500 million/year created for DOE's enrichment facilities. The money is to come from the following: – An annual fee assessed on utilities, based on the ratio of SWU purchased by each utility to the total SWU produced by DOE. – Government appropriations. The total utility liability is capped at $2.5 billion or 15 years, whichever comes first. Cost of environmental remediation stays with DOE.
III. AVLIS	
• Secretary authorized to grant to Corporation the rights and access to AVLIS technology. • Secretary to provide, on a reimbursable basis, the necessary cooperation and support to assure the commercial development and deployment of AVLIS.	• AVLIS is transferred to the Corporation under royalty arrangement. • Corporation cannot construct a commercial-scale AVLIS facility until after privatization begins. • DOE is to be reimbursed for any future R&D on AVLIS. Corporation cannot grant license for patent use.

© NUEXCO 1992

Comparison of Uranium Enrichment Restructuring Legislation *(continued)*	
Senate Bill S 2166	***House Bill HR 776***
IV. URANIUM REVITALIZATION	
• Establishes voluntary overfeeding program. • Establishes national strategic reserve of 50 million kgU. • Enrichment of DOE's tails is restricted to military purposes. • Gives DOE Secretary continuing responsibility for the domestic mining industry. Secretary should encourage exports of domestic uranium. • Requires an ITC investigation of imports of uranium and enriched uranium from non-market countries and a report within one year of enactment of this bill. • Authorizes the Corporation to purchase rather than produce enriched uranium as long as the prices are below its cost of production. • If enriched uranium is purchased, requires feed provided by customer to be retained in inventory or used for overfeeding.	• Requires yearly reports to the Energy Information Administration from utilities. Reports will provide country of origin and seller of uranium or enriched uranium imported into the USA. • All uranium inventories associated with current contract requirements transfer to Corporation. Remainder of uranium inventories held by DOE should be sold at fair market prices. • Requires report on conversion of HEU.
V. MILL TAILINGS CLEANUP	
• $300 million in government funds indexed to inflation.	• Establishes $310 million fund indexed for inflation. $40 million of the fund goes to thorium sites. Source of the funds is D&D fund. DOE must issue regulations, and fund is subject to annual appropriations.
VI. MISCELLANEOUS	
• Repeal of Sec. 161v and 170B of the Atomic Energy Act.	• Section 161v specifically not repealed. Encourages full cost recovery.
• Silent	• Grants the National Taxpayers Union standing to sue to enforce the "purposes" of the Act.
• Silent	• Authorizes the Corporation to enter transactions regarding uranium, enriched uranium, or depleted uranium. Shall act as exclusive marketing agent for US government for entering into contracts for enrichment services.
• Silent	• Current employees are protected: they retain status as government employees. Corporation must abide by union agreement signed 4/30/91 which protects jobs, wages, and benefits.

© NUEXCO 1992

INDUSTRY BRIEFS

South Korea To Build New Fabrication Plant

Korea Nuclear Fuel Company (KNFC) announced in May it plans to build a new fuel fabrication plant at Kongju. The plant, located approximately 170 km from Seoul, will have a capacity of 200 MTU per year for PWR fuel and 400 MTU per year for HWR fuel. The Kongju plant, when combined with the capability of KNFC's other fabrication plant at Taejon, will enable South Korea to manufacture enough fuel to meet the needs of the country's nine existing nuclear reactors. The country has plans to complete eighteen new reactors by the year 2006, of which five are under construction. The new fabrication plant has a projected cost of US$140 million and is expected to begin operation in 1997.

◆ ◆ ◆

Utilities Form E-7 Group

The world's seven largest utilities have formed a group, known as "E-7", to provide a forum for information exchange and cooperation, and to act as a lobbying group for international electricity issues. The members of E-7 include: Electricité de France, Enel of Italy, Ontario Hydro and Hydro Quebec of Canada, Tokyo Electric Power Company and Kansai Electric Power Company of Japan, and RWE of Germany.

Electrabel to Use MOX Fuel

The Belgian utility Electrabel submitted an application on May 18 to load mixed-oxide (MOX) fuel into its 900-MWe PWRs, Doel 3 and Tihange 2. If this request to proceed with the recycling is approved by government authorities, Belgium will join France, Germany, Switzerland, and Japan as countries pursuing commercial fuel recycling. The MOX fuel for the plants will be fabricated by Belgonucleaire at its plant in Dessel.

◆ ◆ ◆

Energy Fuels To Purchase Reno Creek

Energy Fuels Exploration Company announced May 22 that it had signed an agreement with Union Pacific Resources (UPR) to purchase UPR's Reno Creek uranium properties in Wyoming. This acquisition is Energy Fuels' first in-situ leaching property; previously the company produced its uranium conventionally from high-grade breccia pipes in the Arizona Strip.

Argentina to Privatize Nuclear Plants

The government of Argentina recently announced its intent to sell its two operating nuclear reactors to private investors in order to raise cash to complete construction on the country's third reactor. Argentina's Economy Minister stated that the sale of the 600-MWe Embalse HWR and the 335-MWe Atucha I HWR is scheduled for completion by January 1, 1994. The two reactors achieved an average capacity factor exceeding 88 percent in 1991 and contributed more than 17 percent of the nation's electricity supply. The money raised will be used to complete Atucha 2, a 692-MWe HWR, that is approximately three-fourths complete. While the viability of the proposal has been questioned due to the risk and liability that must be assumed by the new owners, the step is part of the Ministry's drive to develop more fully a market-based economy.

◆ ◆ ◆

Japan's 43rd Reactor Achieves Criticality

On May 28, Kansai Electric Power Company's Ohi 4 reactor achieved criticality. Kansai EPC plans for the 1,121-MWe PWR to enter commercial operation in early 1993.

© NUEXCO 1992

TRANSPORTING URANIUM FUELS

The transport of nuclear materials is often overlooked when viewing the front-end of the nuclear fuel cycle. However, when book transfers are not practical, a well-managed transport program is a significant factor in customer satisfaction for nuclear fuel purchases. Some of the logistical considerations of transporting uranium concentrates and uranium hexafluoride include which type of cylinders to use for transport, modes of transport available, sampling, shipment scheduling, and coordination of transportation services. Further consideration must be given to the numerous domestic and foreign regulations, fees, and issues of insurance; however, the complexity of these latter issues prevents their complete analysis in this discussion.

TRANSPORT CONSIDERATIONS

The mode of transport can be aircraft, ship, railroad, truck, or a combination thereof. Generally, a combination of transport modes is needed for a single transport; utilization of combined transports is called intermodal transport. Much of the transport equipment is standardized for handling by more than one mode of transport without opening or reloading. Examples of the most common intermodal equipment are ocean shipping containers (**Figure 1**) and flat racks, that can be transported by steamship, railroad, or truck, and sometimes by aircraft.

Ocean shipping containers are basic 20- or 40-foot long corrugated steel boxes, 8.5 feet high and 8.0 feet wide, with double, full-width doors at one end, and a secondary wood floor. A flat rack is similar, but has two vertical end plates and no top, sides, or doors (**Figure 2**). Not all carriers handle all types of intermodal equipment, so it is necessary to verify compatibility of intermodal transport equipment with all the carriers involved.

Transport equipment, including intermodal, such as truck trailers, railroad cars, and shipping containers, may come in varying lengths, with each length and type having a unique weight limit to be considered in conjunction with inland transport regulations. Likewise, it is important to consider these differences, since each carrier may use only certain sizes of transport equipment. Significant time could be lost if a carrier does not have the equipment available to handle the size of the shipment, or if incompatible equipment requires unloading and reloading.

Trucking, rail, and steamship companies can normally provide the container chassis to transport ocean shipping containers or flat racks on the highways. The chassis is basically a truck trailer frame and running gear on which the ocean shipping container or flat rack is placed. Any carrier who intends to pull the steamship line's equipment must complete an equipment interchange agreement with the steamship line, which allows the equipment to leave the port area and provides liability against damage. The cost in dollars and time to have the container chassis at the pickup location for loading, and to have it returned after unloading, determine which carrier's chassis should be used for delivery.

Another factor to be considered is the shipping facility's handling capacity. Each facility has a limit on the number of cylinders or transport equipment it can load or unload per day. Those limits and their effect upon the shipping schedule are an important element.

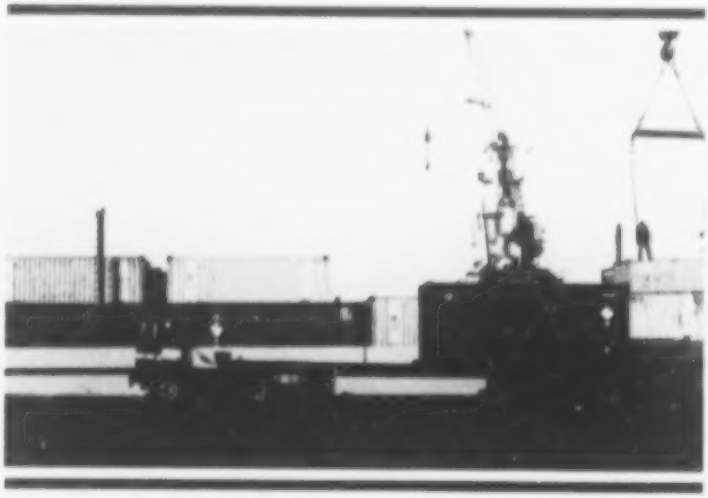


Figure 1 — Ocean Shipping Containers. A 20-foot container on a 40-foot container chassis awaits loading onto a cargo container ship.

© NUEXCO 1992

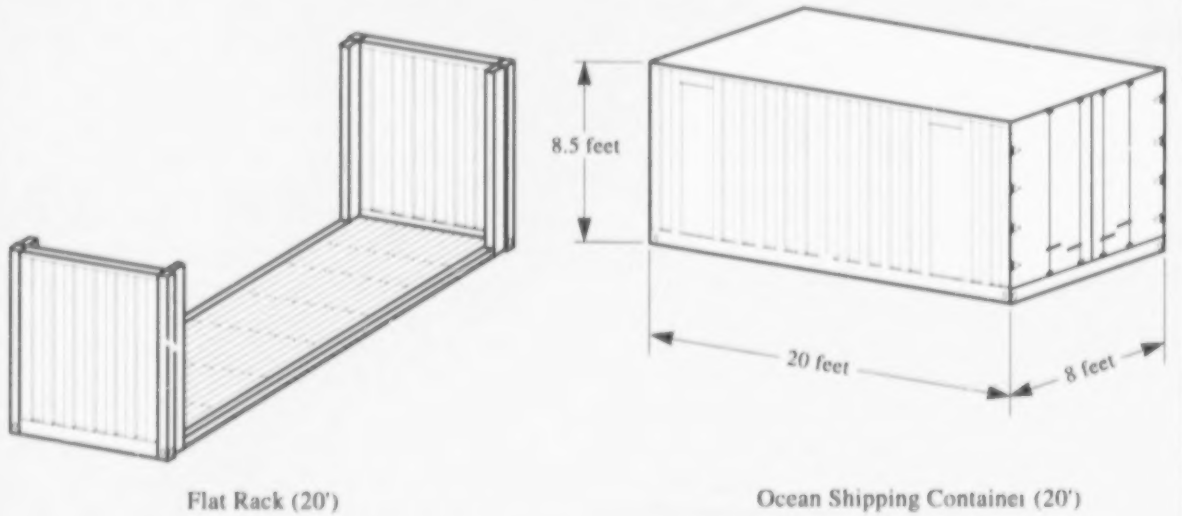


Figure 2 — Typical Flat Rack and Ocean Shipping Container. Both types of transport equipment come in lengths of 20 feet or 40 feet, although the 40-foot lengths are used less often in the transport of nuclear fuels.

Basic Documentation and Fees

• When booking a steamship line, the steamship line agent provides a **booking number**. This booking number is a contract to ship cargo on a particular ship, to and from specific ports, in a particular time frame. The booking number is usually a series of numbers and letters signifying the ship's name, the voyage number, the port of export, and date of export.

• A **bill of lading**, required by US federal law, is a contract between the carrier and the shipper (or its agent) to transport the defined cargo in accordance with all laws and requirements for the specified cargo, and in a reasonable period of time.

• The US Nuclear Regulatory Commission (NRC) and the US Department of Energy (DOE) use a document titled **Form 741** as the primary document for the accountability of nuclear materials. It is the responsibility of the shipping/receiving facilities to complete and distribute Form 741 in accordance with its instructions. To import or export nuclear equipment or materials may require an NRC **import/export license**, per *Title 10 CFR, Part 110*.

• The Department of Commerce, under the Bureau of Census, requires an exporting shipper to file a **shipper's export declaration**, which the Department uses for verification and statistical information gathering.

• For importing, the Bureau of Customs charges a **customs users fee** (except for re-imported US goods) and requires a **delivery verification certificate**, which contains entry information. Any goods passing through a US seaport must pay the **harbor maintenance fee**.

• The US Department of Transportation (DOT) has specific regulations regarding the **transport of hazardous materials**, including radioactive materials. These regulations include specific ways the materials must be referred to on all shipping documents and specific markings that must be displayed on the materials under transport, as well as displayed on the transport vehicles. Uranium hexafluoride (UF_6) qualifies as both a radioactive substance and corrosive substance under *Title 49 CFR, Part 173*, and must be labeled as such.

© NUEXCO 1992

SHIPPING URANIUM ORE CONCENTRATES

Concentrates are usually shipped from the mill to the converter, but sometimes are shipped to, or from, an intermediate storage facility. A mine sells uranium ore concentrates (simply called concentrates) to the customer by the pound of contained triuranium octoxide (U_3O_8) equivalent, with the cost of transportation to the converter commonly included as part of the concentrates' per-pound price.

Concentrates are packaged in 55-gallon drums, supplied by the uranium mill or the converter, that by federal regulation must not allow any leakage during transport. The shipping weight of a 55-gallon drum is approximately 50 pounds empty and 800 to 1,050 pounds when filled with concentrates. Uranium ore concentrates contain between 80 and 98 weight-percent (%) U_3O_8 equivalent. Therefore, a drum of concentrates can contain from 600 to 980 pounds of U_3O_8 equivalent. Buyers and sellers typically use a value of 850 pounds contained U_3O_8 equivalent per drum as an average in quotations. However, as a shipper uses actual weight, money is saved when shipping concentrates closer to the 98 % U_3O_8 than the 80 % level, as less waste material is transported.

Sampling

When a uranium mill has completed the processing of a batch lot of uranium ore (a batch lot of ore usually contains between 35,000 and 50,000 pounds of U_3O_8, the quantity determined by contract), it takes representative samples from throughout the batch lot. The samples are combined into a master sample and then separated into samples of 150 grams U_3O_8 equivalent each, which are put into sample bottles (half-pint mason jars). The mill's portion of the master sample is analyzed by the mill laboratory prior to shipment, to test the level of impurities and to verify that the batch lot meets contractual chemical specifications.

Typically, one sample (the umpire sample) is held on reserve by the mill to be analyzed by an independent laboratory in the event of a dispute between the analytical results of the mill and those of the converter. The independent laboratory's results are usually binding on both parties for settlement. When shipping and receiving facilities have established routine practices and the quality of the product is known, samples are not sent in advance, but are held in reserve in case of a question or formal dispute.

The contract for delivery will contain the exact sample terms and conditions. The converter samples the concentrates when they are received and typically has 30 days to dispute the mill's test results. If material does not meet the contractual specifications, the owner of the material, or the supplier, usually is responsible for the converter's surcharges for reducing the impurities to acceptable levels.

Samples are normally sent by mail or by courier, since they contain internationally exempted limited quantities of radioactive material. Exempted limited quantities of radioactive material include those containing less than 15 grams of ^{235}U, and thus are exempted from having to meet the full licensing and regulations required of larger shipments. Each courier company has its own requirements for shipment, and some choose simply not to handle any radioactive materials, whether exempted or not. By US federal regulation, *non*-exempted quantities of radioactive materials cannot be shipped through the US Postal System or by passenger aircraft.

URANIUM HEXAFLUORIDE

Uranium hexafluoride (UF_6) is a compound formed of hexavalent uranium and fluorine, and has special properties that make it the standard form for shipping and processing uranium. One special property of UF_6 is that at 147°F and 22 psia it has a "triple-point", a rare quality that allows it to exist as a solid, liquid, and a gas, all at the same time. The fact that the requisite temperature and pressure are relatively low is useful for production, as it allows UF_6 to be used as a gas in processing, as a liquid for feeding into and withdrawing from storage, and as a solid while in storage or transit. UF_6 as a liquid, even though it is heavy, has a low viscosity that allows it to flow freely. This special property eases its loading into and out of pressure cylinders. Another special property of liquid UF_6 is that it does not react with oxygen, nitrogen, carbon dioxide, or dry air. However, liquid UF_6 is not stable at normal atmospheric pressure, and does react rapidly with water vapor, as does the exposed surface of solid UF_6, releasing corrosive hydrogen fluoride. Therefore, UF_6 is always handled in leak-tight containers and processing equipment to avoid reaction with the moisture in normal atmosphere.

© NUEXCO 1992

NUEXCO

BASIC CONSIDERATIONS

Uranium constitutes approximately 67.6 percent of the weight of UF_6. The natural enrichment of the uranium contained in UF_6 is 0.711 w/o uranium-235 (^{235}U, the fissile isotope of the element uranium). References to "UF_6" usually infer UF_6 at natural enrichment levels. *Enriched* uranium hexafluoride is more commonly referred to as enriched uranium product (EUP). For transport definitions, EUP is UF_6 that contains more than, or equal to, 1.0 w/o ^{235}U.

A conversion facility receives concentrates, and then returns UF_6 at natural enrichment levels. The ^{235}U content in UF_6 is increased to the desired level at an enriching facility. The majority of the world's commercial nuclear reactors are the light-water type, and thus require the level of ^{235}U in UF_6 to be increased to between 2.5 w/o and 4.5 w/o, depending on the particular design and operation of the reactor. This EUP is then processed at a fabrication facility into UO_2 pellets that are loaded into fabricated fuel rods to be used in a nuclear reactor. Transportation is required after each phase of the front-end cycle and is usually subcontracted to a specialty transportation carrier. Shipping of the fabricated fuel rods is handled by the fabricator, however as the design and dimensions of the fuel rods for US reactors are generally unique to each reactor and therefore require specialized handling and shipping containers.

Shipping Natural UF_6

UF_6 is packaged at the converter's facility into cylinders that US federal regulations require to be designed and built to American National Standards Institute (ANSI) design N14.1 standards. The International Atomic Energy Agency (IAEA) has standards for UF_6 cylinders too, which supercede any domestic standards. The IAEA is working with a number of countries to develop new standards to be used internationally by 1993.

Steel UF_6 cylinders with valves have been made in two common sizes (outside of the former Comecon-member countries): the 10-ton (Model 48X) and the 14-ton (Model 48Y) (**Figure 3**). Uranium hexafluoride, both natural and enriched, corrodes the mild steel used in these cylinders. However, UF_6 corrosion forms a film which significantly reduces further corrosion, making the use of more expensive metals unnecessary.

The majority of US conversion facilities use the 48Y cylinder for shipping because it holds 25 percent more material per cylinder than the 48X model; therefore, more UF_6 can be filled/emptied with less cylinder handling. Also, 48X cylinders are not acceptable to the IAEA for international shipment; they are used occasionally for domestic shipments, but now are used primarily for additional storage.

Uranium hexafluoride normally enters a cylinder as a liquid, but contracts when it changes to its solid form after filling. Since it has one of nature's largest expansion factors, gaining nearly a third in volume when changed back from a solid to a liquid, the legal limit for filling a UF_6 container is 61 percent of capacity. Because of the UF_6 expansion factor, it is very important that cylinders not be overfilled. If care is not taken to observe caution in filling, which is done under pressure, the expansion of the UF_6 when returned to its liquid state could rupture the cylinder.

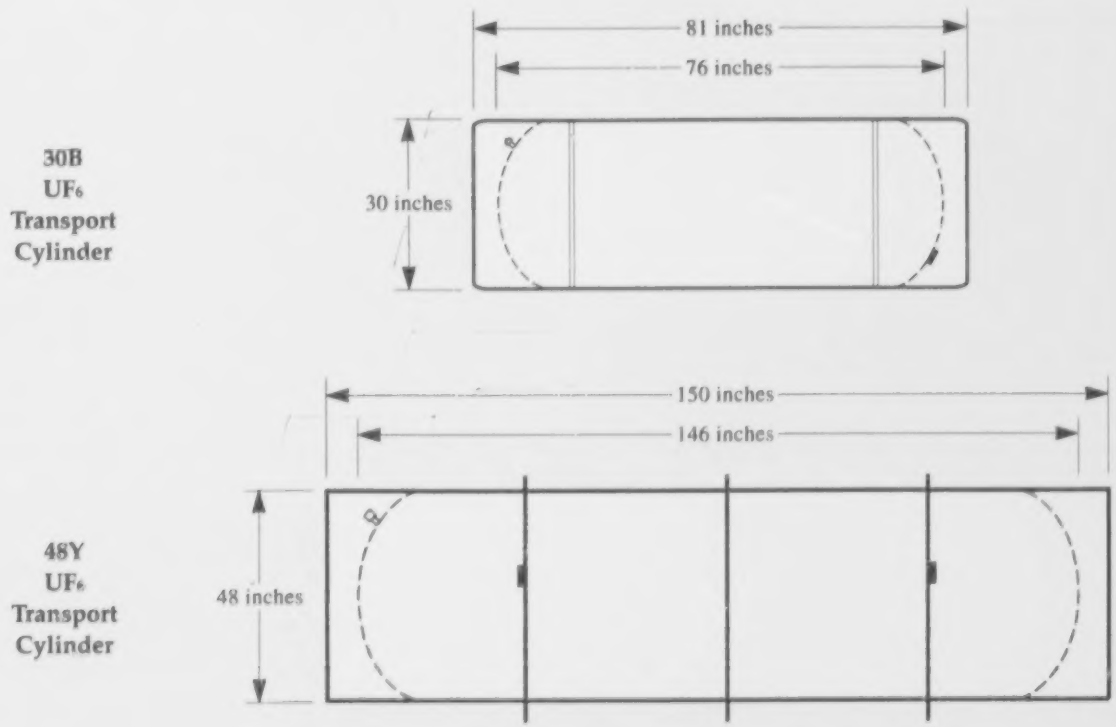
For shipping, consideration must be given to the quantity of UF_6 and its destination, to determine how many cylinders are required, and the mode(s) of transport. The time required for filling the cylinders and making preparations for shipment, is also a consideration, since the time necessary for filling and preparation varies with each contract and conversion facility. Further, a shipment of UF_6 may require four shipments—empty UF_6 cylinders shipped to the loading facility, full cylinders shipped to the enrichment facility, emptied cylinders possibly shipped to a cleaning facility, and the cleaned/empty cylinders shipped to a designated return location.

Sampling

European and North American converters take samples of the UF_6 in each cylinder at the time the material is withdrawn from the conversion line and loaded into the cylinder. A 2S-type sample cylinder is usually used for these in-house samples (**Figure 4**).

© NUEXCO 1992

Figure 3
30B AND 48Y TRANSPORT CYLINDERS



UF6 CYLINDER DATA

	(unit)	30B	48Y
Nominal Diameter	inch	30	48
Nominal Length	inch	81	150
Basic Material (spec. ASTM A-516)		Steel	Steel
Empty Weight	pound	1,400	5,200
Max. UF_6 Weight	pound	5,020	27,560
Max. Gross Weight	pound	6,420	32,760
Max. Volume	cubic feet	26	142.7
Service Pressure Limit	psig	200	200
Isotopic Content Limit (with moderation control)	$^{\%}_{0}$ ^{235}U	5.0	4.5

© NUEXCO 1992

Figure 4
1S AND 2S SAMPLE BOTTLES

SAMPLE BOTTLE DATA			
	(unit)	1S	2S
Nominal Diameter	inch	1.5	3.5
Nominal Length	inch	11.0	11.5
Basic Material	—	nickel	nickel
Empty Weight	pound	1.75	4.2
Max. UF_6 Weight	pound	1.00	4.9
Max. Gross Weight	pound	2.75	9.1
Max. Volume	cm^3	150	736
Service Pressure Limit	psig	200	200

Samples are not generally sent to the enrichment facilities in advance. However, shipments of UF_6 sent to Russia for enrichment must have the 2S sample cylinder attached to the skirt of the 48Y cylinder from which the sample was taken. The sample must have a tamper-indicating seal, and be enclosed in a box bolted with two bolts onto the 48Y cylinder, in the eight o'clock position. The sample box itself also must be sealed with a tamper-indicating seal.

The conversion facility keeps samples of the UF_6 to check its quality prior to shipping and, as in the case of concentrates, as umpire samples in case of a dispute. The receiving enrichment facility also may take samples from the cylinders and test the samples prior to feeding the UF_6 into its enrichment processing lines. Which party bears the cost of restoring non-specification material to contract specifications is a matter for contract negotiations.

Commercially Enriched UF_6

EUP is packaged at the enrichment facilities into a steel cylinder, which is then placed in a protective shipping package (PSP), also called an overpack (**Figure 5**). The EUP cylinders used are usually Model 30B, which replaced the Model 30A previously used. The two cylinder types are visually distinguishable, as the 30B has convex ends (Figure 3), while the 30A has concave ends. The 30A was designed to contain the EUP during normal transport conditions, while the 30B is designed to survive accident conditions—the reason for its frequent use today. Because the 30A cylinder was not designed to survive accident conditions, it is no longer approved by the IAEA for international shipments and will not be accepted at DOE facilities after December 31, 1992.

The PSP is used to physically separate the cylinders to avoid any possibility of a critical chain reaction. The PSP also protects the cylinder and its valve from injury in transportation accident, which may or may not involve fire. A PSP consists of a cylindrical double shell with top and bottom halves. The 6.5-inch thick shells are composed of stainless steel inner and outer liners, with the space between them filled with a fire resistant insulation, such as phenolic foam. Each shell half has an internal framework of rolled angle sections, and the bottom half of the shell has a cradle, formed from angle iron, welded to it. The cradle has four feet with holes, allowing the PSP to be bolted to the floor of the trailer, ocean shipping container, flat rack, railroad car, or aircraft cargo floor (**Figure 6**). Except for aircraft, this custom bolting is one of the main reasons transportation equipment has a secondary floor of wood, as it makes attachment easy. Both halves of the PSP have four shock-absorbing pads, and twenty vents designed to allow gases to escape in the event of fire. The vents normally are sealed from moisture by plastic caps. The top and bottom halves of the overpack are sealed by a rubber gasket, and joined with fourteen bolts and nuts.

© NUEXCO 1992

Figure 5 — 30B Cylinders in PSPs. Two 30B cylinders in their protective shipping packages are moved into position in a freight staging area.

Empty cylinders usually need to be at the enrichment facility two to three months in advance of the contractual delivery date to allow the facility time to examine the cylinders and complete any maintenance required before filling them. The PSPs must be at the enrichment facility a week in advance, but normally are delivered earlier to assure time for examination and approval. Conditions that normally require further inspection or removal from service are: excessive warping, distortion, or other damage to the liner or shell that prevents a tight closure of the package; excessive clearances for the inner container from the liner; fastener damage or loss; reduction in thermal insulation thickness in any area; and any other damage or condition that would bring into question the integrity of the PSP as a fire- and shock-resistant housing.

Another important consideration in scheduling shipments of EUP is that its transport may actually entail up to six separate shipments: the shipment of the cylinders and the PSPs to the enrichment facility (possibly from different locations), the shipment of the EUP from the enricher to the fabricator, the return shipment of the PSPs, and the return shipment of the empty cylinders, which may also require an interim shipment to another facility for cleaning.

For shipping, EUP is typically measured in kilograms, and one cylinder can transport approximately 1,500 kilograms of EUP, enriched to less than 5.0 w/o ^{235}U. Ready for shipping with its overpack, the 30B has a gross weight of 8,200 pounds. The size and weight of the cylinders with PSPs are both important for calculating ocean and European railroad rates, since these rates are based on the greater of size or weight.

With an effective US domestic highway weight limit of about 38,000 pounds of cargo, five or six partially filled cylinders with their PSPs are all that can be transported on a 40- or 45-foot truck trailer. Yet, on a 20-foot trailer, four full cylinders with PSPs will fit. Easily recognized is the fact that the 40- or 45-foot truck trailers are not able to use their space as efficiently as the 20-foot trailers. Adding to the difficulty in selecting the appropriate transport equipment length is that steamship lines charge a flat rate which is more cost efficient for shipping 40-foot equipment than 20-foot equipment.

© NUEXCO 1992

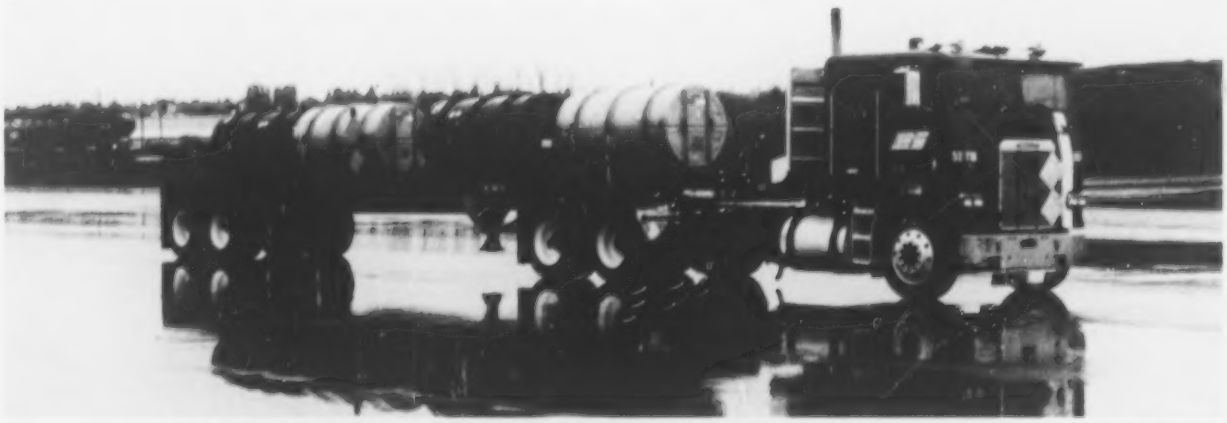


Figure 6 — 30B Cylinders in PSPs bolted on a flatbed truck trailer.

Sampling

Samples of EUP are taken by the enrichment facility under observation by a witnessing agent of the customer. The enrichment facility draws an umpire sample, an in-house sample, a sample for the fabricator's laboratory, and a sample for the witnessing agent. The facility then sends a sample to a laboratory designated by the fuel fabricator for analysis prior to shipment. Samples are generally secured in 1S bottles (Figure 4), except for the laboratory sample which is normally placed in a P10 tube. Such samples may exceed the maximum allowed 15 grams of ^{235}U for exemption, and therefore require the same licensing and documentation as the main shipment.

CONCLUSION

Certainly there are many more details, and situation-specific issues, but even this basic overview of the physical aspects of transporting uranium fuels illustrates the large number of intertwined considerations of costs, time, location, equipment, and documentation. With prices falling in the uranium industry, the margin of profitability on uranium sales is low, making transportation cost an especially significant issue. ●

Jeffrey D. Price
Alan L. Wolcott

© NUEXCO 1992

NUCLEAR FUEL REPROCESSING

The reprocessing of irradiated nuclear fuel is one of two alternatives currently employed to manage spent fuel discharged from commercial nuclear reactors, the other method being interim storage of spent fuel followed by permanent disposal. In the early years of commercial nuclear power, evaluations indicated reprocessing was an economical fuel management method. Consequently, most countries with nuclear generating capacity chose to pursue some level of reprocessing.

From a technical viewpoint, reprocessing followed by recycling is feasible and more efficient in resource utilization than storage and permanent disposal of spent fuel. This efficiency, plus reprocessing capability from plants built for military purposes, caused France and the United Kingdom (UK) to select the reprocessing option early in their nuclear history. Many other countries have chosen to store spent fuel on a long-term basis until reprocessing facilities are constructed, and have contracted with France or the UK for reprocessing services.

In spite of these commitments, only thirty percent of the over 120 thousand metric tons of commercial spent fuel discharged since 1963 has been reprocessed. The remainder has been stored pending reprocessing or the development of permanent disposal facilities. Of the countries pursuing reprocessing, only the UK, France, and the former Soviet Union have developed significant commercial reprocessing capacity. India and Japan have installed reprocessing plants of relatively small capacity, and the CIS (which contains the facilities of the former Soviet Union) and Japan are currently building large additions to their facilities.

The USA, Canada, Sweden, and several other countries have elected not to use reprocessing. Nations such as Spain, South Korea, Mexico, and others have postponed their decision on permanent disposal and have selected long-term, interim storage of spent fuel as their current method of ending the nuclear fuel cycle. It is important to note that closed fuel cycles (reprocessing followed by recycling), as well as open fuel cycles (storage followed by permanent disposal) require facilities for permanent disposal of high-level wastes (**Figure 1**). However, to date, there are no licensed, permanent disposal facilities for spent fuel or high-level waste anywhere in the world. Temporary, long-term storage of spent fuel and high-level wastes will continue until the interim storage facilities are filled to capacity or until permanent disposal facilities are constructed and licensed.

Since most of the spent fuel that has been reprocessed is stored as uranium (U) and plutonium (Pu), two of the most important issues currently affecting the reprocessing cycle are the development of facilities to fabricate fuel from the recovered plutonium and uranium, and the licensing of power plants to use these fabricated fuels. Fabrication capability for mixed oxide (MOX) fuel has been successfully developed and installed, principally in Germany, but the world capacity for fabricating MOX fuel is much too small relative to the existing amounts of recovered plutonium and uranium. In addition, while the use of MOX fuel in light water reactors has been well developed and tested, few reactors worldwide are licensed or inclined to use MOX fuel, principally because it is not economical compared to inexpensive fresh uranium. Fast breeder reactor (FBR) technology that uses plutonium also has been slow in developing, and currently only a few FBRs exist. Nevertheless, the tremendous financial investments already made in reprocessing capability likely will deter rapid departure from the use of reprocessing.

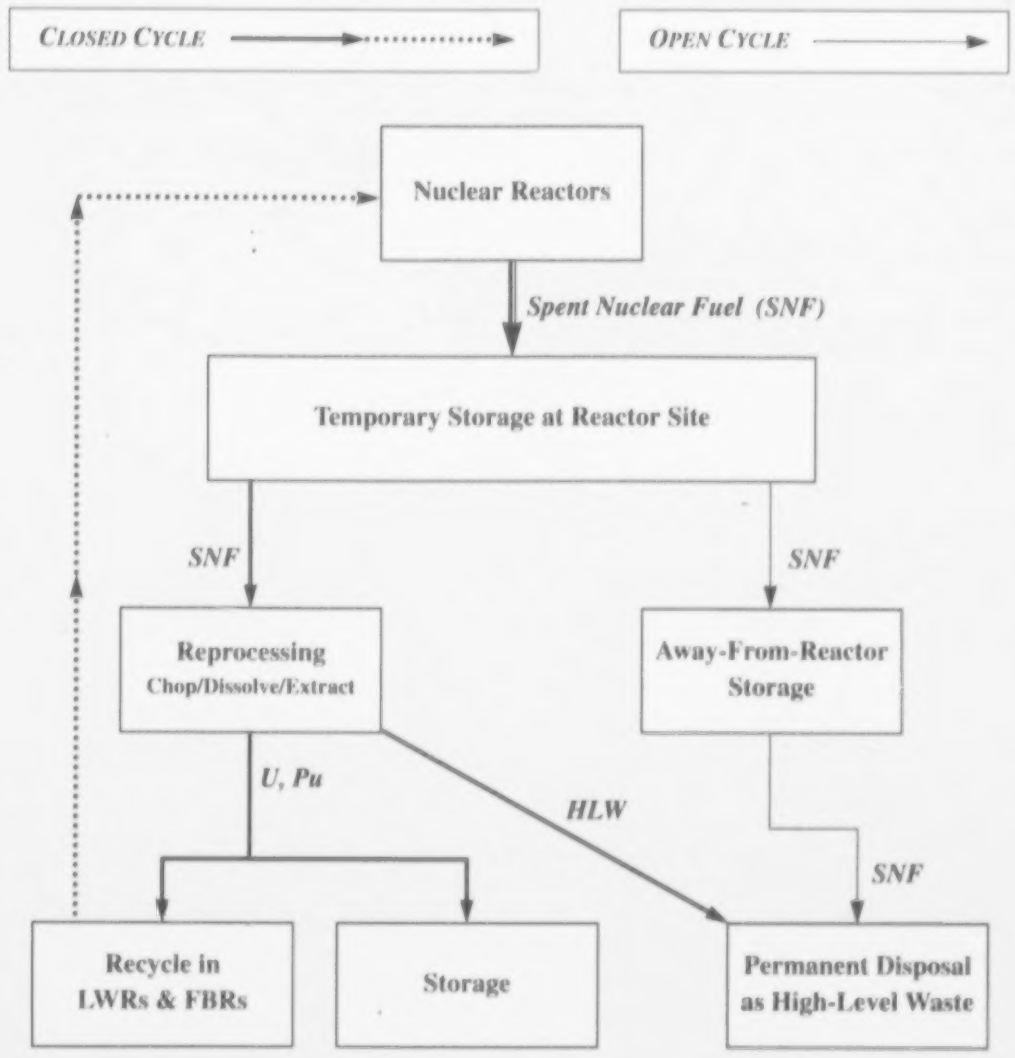
Other issues affecting the use of reprocessing include: accountability (from both a criticality and a safeguards viewpoint); proliferation-resistant processes; transport and storage of large amounts of plutonium; environmental protection from highly toxic plutonium; and the ultimate fate of the liquid, gaseous, and solid high-level wastes that result from reprocessing activities.

THE PROCESS

Spent fuel has been reprocessed since the early 1950s, and although the technique is simple in concept, it is complex in practice. It is similar to other industrial processes that extract valuable material from wastes, but has the added complexities of radioactivity, criticality, and toxicity.

© NUEXCO 1992

Figure 1
SPENT FUEL MANAGEMENT OPTIONS



© NUEXCO 1992

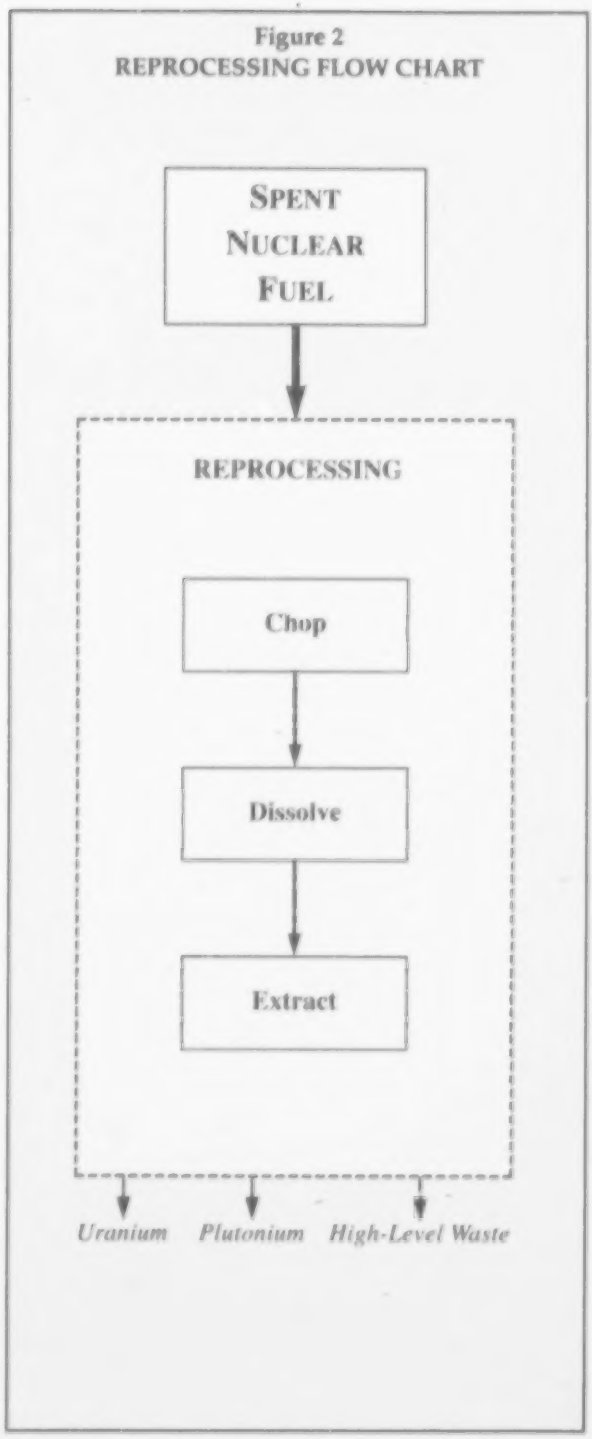
Basically, the process can be described by the chop-dissolve-extract phases. The spent fuel is disassembled and mechanically chopped into small pieces, dissolved in hot nitric acid, and then subjected to chemical extraction of uranium, plutonium, and wastes (**Figure 2**).

The activities performed in the reprocessing of oxide fuel from thermal, light water reactors are essentially the same in all facilities worldwide. Spent fuel assemblies arrive at the reprocessing facility by truck or rail, in shielded, cooled containers, which are then vented and purged. The fuel assemblies are removed from the containers under water and stored until they are ready for processing. The assemblies are checked for fissile content, burn-up, and cooling time and then transported to the shearing station. At this station, the fuel assemblies lie horizontally under hydraulically drawn cutting blades that shear the fuel and cladding into small pieces. The pieces fall into a basket submerged in a dissolver of hot nitric acid. Shearing and dissolving occupy about two eight-hour shifts at the THORP facility in the UK, which has a dissolver capacity of 1.7 tonnes of sheared fuel.

During dissolution, some volatile products are discharged as gases, some are precipitated as solids and cast in cement for disposal, and others are discharged in aqueous streams. The residual cladding is encapsulated in cement for disposal. The dissolver liquor is centrifuged to remove fission-product solids and bits of cladding that are also encapsulated for disposal. The clear dissolver liquor is then conditioned in preparation for the extraction of the plutonium and uranium, and stored until ready for the extraction by chemical separation.

The plutonium and uranium extraction processes used throughout the world are variations of the PUREX (Pu-U-Recovery-Extraction) process. One typical variation employs uranous nitrate/hydrazine and nitrogen oxides as the plutonium reducing and oxidizing agents. Hydroxylamine also is used as a reducing agent at selected stages. Separation of plutonium and uranium occurs in pulsed columns, and the resulting plutonium solution is precipitated by an oxalate process. The precipitate, plutonium oxide, is then stored. The uranium solution resulting from the separation, uranyl nitrate, is converted to uranium trioxide in fluidized beds, using the thermal denitration process. The trioxide powder is then placed in drums for storage.

Figure 2
REPROCESSING FLOW CHART



© NUEXCO 1992

Offgases and liquid radioactive wastes are treated as follows. Gases from denitration are cooled and condensed, and the liquors routed to evaporators for treatment and acid recovery. Oxides of nitrogen are converted and the inert materials discharged. High- and medium-level wastes are sent to evaporators for concentration, solidification, vitrification, and disposal; low-level wastes are selectively discharged or prepared for disposal, thus completing the reprocessing portion of the cycle.

PROLIFERATION AND SAFEGUARDS

One of the major issues regarding reprocessing, and an often-named drawback, is proliferation. This concern was a primary factor in the decision of several countries, including the USA, not to reprocess. Throughout the world, governments, companies, and individuals have expressed concern that the element separation that occurs during the reprocessing cycle isolates material, in particular, plutonium, that could be diverted by a country or terrorist group to make a nuclear weapon. While the likelihood of this occurring is very low and the development of a weapon from such material would be extremely difficult, it is technically feasible, and this has led several countries to decide against a closed fuel cycle for their commercial nuclear power program.

In 1977, US President Carter initiated two studies, one domestic and one international, to examine non-proliferation issues. Both the US-based Nonproliferation Alternative Systems Assessment Program (NASAP) and the International Nuclear Fuel Cycle Evaluation (INFCE) studies reached some similar conclusions. The three-year studies found that while no nuclear fuel cycle was 100-percent "proliferation proof", the diversion and misuse of material from civilian nuclear facilities was unlikely and was not an easy or efficient means for a group to develop a weapon. The reports also found that while reprocessing and recycling could save uranium and were economically feasible, existing political and regulatory barriers counteracted any economic benefit. NASAP favored an open fuel cycle as more proliferation-proof, since it makes it more difficult to isolate the material necessary for weapons; INCFE stated there was little safety difference in the two cycles. However, both studies strongly agreed that stringent safeguards were the best means of assuring non-proliferation.

Since the time of these studies, the economic benefits of reprocessing have decreased with the falling price of natural uranium, and weapons proliferation issues, after being a lesser concern in the 1980s, have re-emerged as an important global issue. The primary means of proliferation detection is accomplished by the Department of Safeguards of the International Atomic Energy Agency (IAEA). The IAEA accounts for uranium and plutonium throughout the world, using safeguards guidelines from the 1968 Treaty on the Non-Proliferation of Nuclear Weapons (NPT) and from individual safeguards agreements with each country. The IAEA has done an outstanding job tracking material, but the effects of zero real growth in IAEA funding since 1983 were illustrated by the weapon-development discoveries made in Iraq following the war in the Persian Gulf. As a result, there are now frequent calls to enhance IAEA's safeguards enforcement abilities, and decisions as to which fuel cycle to adopt are being closely examined. Nevertheless, the safeguards system now in place does an excellent job of accounting for radioactive materials, and the decision whether or not to pursue the reprocessing and recycling option is primarily an economic choice.

REPROCESSING IN SELECTED COUNTRIES

France

France is a world leader in research and development for reprocessing. The country is committed to a closed nuclear fuel cycle and currently has a total reprocessing capacity of over 1,500 metric tonnes heavy metal (MTHM) per year at three plants and is expanding capacity (**Table 1**). The first plant, designated UP1 (Usine de Plutonium-1), was commissioned in 1958 and is located at Marcoule in southern France. The UP2 and UP3 plants are located at La Hague in northwestern France and were commissioned in 1966 and 1992, respectively.

The UP1 facility initially was committed to defense work only, but now also handles civilian reprocessing of metallic fuels from gas-cooled (GCR) and fast breeder reactors. It has a capacity exceeding 600 MTHM per year. Experience gained at UP1 was used in the design of UP2,

© NUEXCO 1992

Table 1
COMMERCIAL REPROCESSING CAPACITIES BY COUNTRY
(Metric Tons Heavy Metal Per Year)

Country	Current	Planned Additions	Total
France	1,500	700	2,200
United Kingdom	1,500	1,200[1]	2,700
Commonwealth of Independent States	400+	1,500	1,900+
Japan	210	800	1,010
Germany	Shutdown	0	0
TOTAL	3,610+	4,200	7,810+

[1] THORP facility is operating, and will complete its two-year commissioning process later this year.

which handles only metallic fuels from GCRs. Reprocessing capabilities for LWR fuel were added to UP2 in 1973 and for FBR fuel in 1979. UP2 currently has a capacity of 400 MTHM per year and is in the process of being upgraded to 800 MTHM per year to handle domestic oxide fuel only. This expansion is scheduled for completion in 1993. For reference purposes, the pre-expansion plant has been designated UP2-400, and the new, post-expansion plant, UP2-800.

UP3 became fully operational in late 1990 and was commissioned on April 14, 1992. It contains state-of-the-art processes that reduce worker radiation exposure and lower the volume of waste. Six countries—Japan, Germany, Sweden [1], Switzerland, Belgium, and The Netherlands—provided US$5 billion in financing to build UP3, which will reprocess foreign fuels exclusively. Cogema, the French company responsible for all reprocessing activities in France, has take-or-pay, cost-plus-fee contracts with these countries. The initial capacity of UP3 is 500 MTHM per year, and is expected to be increased to 800 MTHM per year during the next two years. To facilitate fabrication of mixed-oxide fuel, improvements planned for UP3 include a unit to remove americium from plutonium. Long-term research and development on neptunium removal underway in the Atalante program at the Marcoule research center was postponed for a year to reduce costs and allow rethinking of research on reprocessing.

A technological risk report released in early 1991 called for reconsideration of France's entire nuclear fuel cycle. The report recommended that a plan for the final disposal of nuclear wastes, currently stalled in France, become the focus of attention. The report also questioned the continuation of reprocessing because there is currently little use for recycled fuel: there is insufficient MOX fabrication capacity, the MOX program for reactors has not progressed as planned, and fast breeder reactors have made even less progress. Furthermore, there are no existing programs expected to be able to consume the plutonium or the reprocessed uranium made available by reprocessing. In addition, France has contracts for reprocessing foreign spent fuel, and there is the possibility the countries with which it has contracted will refuse to take the reprocessing wastes, leaving France with additional disposal problems. The report recommended direct disposal of spent fuel without reprocessing as a better spent fuel management method, since there would be no reprocessing wastes and no plutonium or reprocessed uranium produced. Nevertheless, Electricité de France, the French national utility, stated in February 1992 that its spent fuel reprocessing policy was unchanged, and that thermal recycling of plutonium was still attractive, but must be matched with the capacity of the reprocessing facilities.

France has made a long-term commitment to reprocessing domestic and foreign fuel, and has invested large sums of money in reprocessing and recycling technology. Several countries totally depend upon France to do their reprocessing. For these reasons, French reprocessing policies are not likely to change soon, even though many factors are leading the country to re-examine its spent fuel management options.

[1] Sweden initially had contracts to reprocess at the UP3 facility and provided some funding for its development, but has since changed its decision, and is not reprocessing its spent fuel. The country's contracts have been assigned to customers from Japan, Germany, and Switzerland.

© NUEXCO 1992

United Kingdom

The UK is committed to the reprocessing cycle and has reprocessed more spent fuel than any other country, producing more than 30 thousand metric tons in the last 30 years. The country currently operates more than 1,500 MTHM per year of reprocessing capacity at two primary plants. The British Nuclear Fuels plc (BNFL) Magnox reprocessing plant at Sellafield was started in 1952, and expanded in 1964 to a capacity of 1,500 MTHM per year. The plant reprocesses only metallic uranium from Magnox reactors, all of which are fueled by natural uranium. The Thermal Oxide Reprocessing Plant (THORP), also located at Sellafield, was built to reprocess enriched uranium fuel from light water reactors (LWR) and advanced gas-cooled reactors (AGR), and is currently going through a two-year commissioning (**Figure 3**). Its first-decade baseload capacity is 7,000 MTHM, with a target annual capacity of 1,200 MTHM per year. THORP reprocessing has been contracted for by utilities in the UK and in seven other countries: Japan, Germany, Switzerland, Spain, Sweden[1], Italy, and The Netherlands. Early contracts were the take-or-pay, cost-plus-fee type; more recent contracts use fixed-price terms. The UK also operates a small MOX fuel reprocessing plant at Dounreay with a capacity of 8 MTHM per year.

The UK has recycled considerable quantities of reprocessed material through the Magnox and AGR plants. For instance, approximately 75 percent of the initial cores for the AGR reactors was reprocessed material. Further recycling will be based mainly on fuel-cycle economics. Nuclear Electric recently completed a US$23 billion contract with BNFL involving reprocessing, fabrication, and decommissioning. Not all of the future discharges of spent fuel from Nuclear Electric's AGRs are covered by the contract, leaving the opportunity for a future decision by Nuclear Electric regarding long-term storage versus reprocessing. Scottish Nuclear Ltd. (SNL) also concluded long-term arrangements with BNFL, under which SNL committed to the reprocessing of an additional 330 tons of spent fuel, beyond the 618 tons already committed. In addition, the company announced that it had selected long-term dry storage for the rest of its AGR spent fuel. Thus, in spite of BNFL's heavy investment in reprocessing and commitments to other countries, UK utilities have demonstrated a desire to maintain their options and to lessen their commitment to reprocessing.

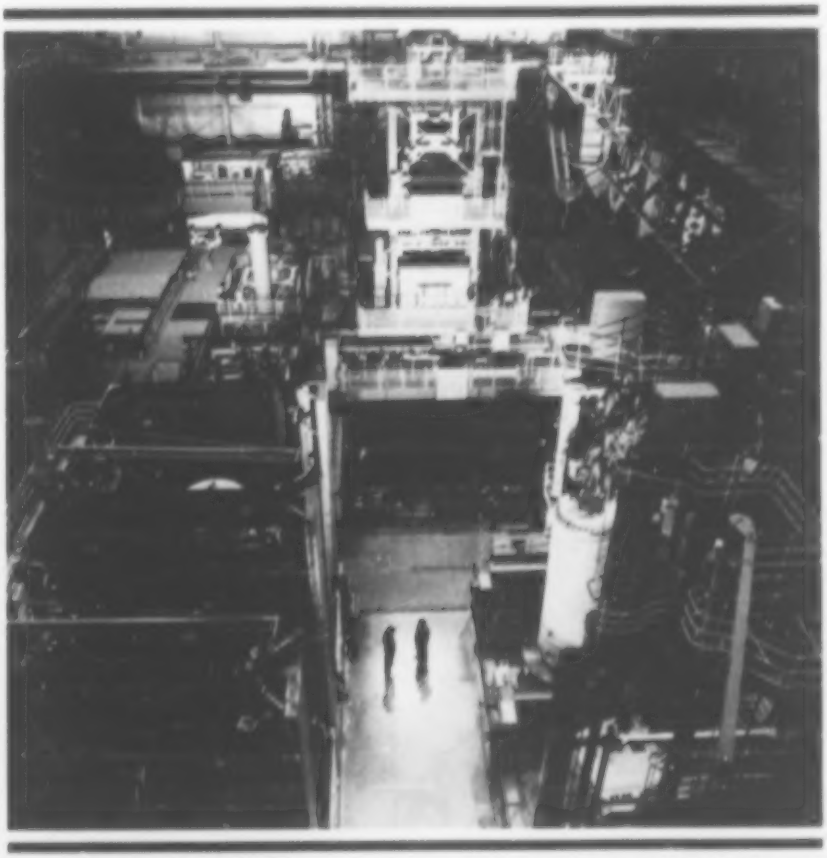


Figure 3 — THORP Facility. Receiving and storage area at BNFL's thermal oxide reprocessing plant. (*Photo courtesy of BNFL*)

© NUEXCO 1992

Commonwealth of Independent States

The Commonwealth of Independent States (CIS) is committed to the reprocessing cycle and operates reprocessing plants at two known sites in Russia. The Chelyabinsk-40 reprocessing plant is near Kyshtym on the eastern side of the Ural Mountains. The plant began operation in 1949 reprocessing military reactor fuel, and was modified in 1978 to handle naval reactor fuel. Today it has a capacity of 400 MTHM per year and reprocesses spent fuel from VVER-440 reactors in the CIS and central European countries, although no fuel has been accepted from these countries since 1990. The Tomsk reprocessing plant, near the city of the same name in Siberia, has operated since the mid-1950s at an undisclosed capacity. In 1978, it began reprocessing military production reactor fuel. Russia announced recently that it plans to restart construction on a third reprocessing plant at Krasnoyarsk with a 1,500 MTHM-per-year capacity.

The process used at Chelyabinsk is basically the same as that used by Western reprocessors, except that after three years of cooling, the hexagonal VVER-440 fuel is disassembled using an arc saw to remove the ends. The rods are then flattened to crack the pellets and fragmented by blades to separate the cladding and the oxide material, all of which is then dissolved in hot nitric acid. The PUREX process is used for separating plutonium and uranium, followed by purification using solvent extraction.

Scientists in the CIS have identified the recycling of uranium and plutonium as an urgent nuclear fuel cycle problem. As a result, they have fabricated and tested MOX fuels in fast breeder reactors. However, recognizing the delay in introducing FBRs in the CIS, they have turned to recycling uranium and plutonium in thermal reactors.

Reprocessing spent fuel has been carefully studied in the CIS, as has storage and disposal. Reprocessing has the drawback of creating hard-to-handle liquid and gaseous states of uranium, plutonium, and fission products, in contrast to the easier to handle, mostly solid materials dealt with in spent fuel storage and disposal. Nevertheless, reprocessing continues to be the fuel cycle policy of choice in the CIS, a decision probably carried by the inertia of earlier decisions to use reprocessing for military purposes.

Japan

Japan currently operates a 210 MTHM-per-year reprocessing plant at Tokaimura, and is constructing a larger, 800 MTHM-per-year plant at Rokkashomura on the northern end of the main island of Honshu. In the meantime, Japan has sent most of its spent nuclear fuel to BNFL in the UK and COGEMA in France for reprocessing. The first shipments of separated uranium, plutonium, and wastes from the reprocessing are to be returned to Japan beginning this year, as specified by the contracts with BNFL and Cogema.

Japan's commitment to reprocessing is coupled with the philosophy that recovered uranium and plutonium should be used domestically as an energy resource. Recycling would provide efficient use of uranium and less dependence on foreign uranium sources. In addition, reprocessing is preferred in Japan as a proper management method for disposal of wastes from spent fuel.

The construction of the reprocessing plant at Tokaimura began in 1971 by the Power Reactor and Nuclear Fuel Development Corporation (PNC). The design was carried out by the French company Societé Generale pour les Techniques Nouvelles (SGN), testing began in 1974, and the plant was commissioned in 1981. It has been operating near its design capacity since 1983.

The company in charge of construction of the new reprocessing facility at Rokkashomura is Japan Nuclear Fuel Services Co., Ltd. (JNFS). Although preliminary civil engineering began in 1988, the beginning of construction of the plant has suffered several delays and is now scheduled for December 1992. The plant, which has an estimated cost of US$6.2 billion, will utilize technology from France, the UK, and Germany. By the time the new plant begins operation in 1999, the planned nuclear generating capacity of Japan will have exceeded the expected reprocessing capacity of the Rokkashomura plant, so extensive facilities for spent fuel storage also are planned. Even so, Japan may have to continue sending spent fuel to France and the UK for reprocessing. The possible reduction or withdrawal of Japan from European reprocessing early in the next century is of great concern to maintaining the viability of European reprocessing facilities.

In regard to recycling, Japan has announced its plan for the use of plutonium. The country's intent is to recycle plutonium as MOX fuel for LWRs and advanced thermal

© NUEXCO 1992

reactors (ATR), and to pursue actively the development of fast breeder reactors for utilization of plutonium, while following a strict non-proliferation policy. Japan already has built two experimental FBRs, Joyo and Monju, and has two ATRs, one at Fugen and the other at Ohma. In addition, the European Fast Reactor R&D Steering Committee, a French, British, and German partnership that has been successful in coordinating FBR R&D under severe national budgeting pressure, recently signed a memo of agreement with four Japanese companies for cooperation and coordination of fast breeder activities.

That Japan is starting construction of a large reprocessing plant at the same time that France and the UK are rethinking their commitments to reprocessing is ironic, as is Japan's announced schedule for massive use of plutonium shortly after the European Fast Reactor project was delayed three years for technical and political reasons. Clearly, the potential for a limitless, recyclable fuel offered by the use of FBRs and the resulting national independence of fuel supply, are the forces driving Japan into large investments in reprocessing and recycling.

Germany

Until 1991, Germany had been committed by law to reprocessing as long as it was technically and economically feasible. In early 1991, the law was revised to make spent fuel storage and direct disposal legally equal to reprocessing, thereby allowing utilities to select either option. German utilities also are legally responsible for their spent fuel and wastes. However, because Germany's facilities and plans for reprocessing have been shut down, primarily for political reasons, many of the utilities have contracted with COGEMA and BNFL for reprocessing services. Plans for a 350 MTHM-per-year, national, commercial reprocessing plant at Wackersdorf in Bavaria were cancelled in 1989. The cancellation of Wackersdorf led to the 1990 closure of the WAK pilot reprocessing facility (Wiederaufarbeitensanlage Karlsruhe Betriebsgesellschaft mbH), a 35 MTHM-per-year facility operating since 1971. In addition, as a result of a bilateral agreement between France and Germany to study reprocessing, and the budgetary pressure of German reunification, the Karlsruhe Nuclear Research Center has shut down its R&D work on reprocessing FBR fuel.

In the recycling area, Germany has a mature mixed-oxide program, including MOX fabrication facilities at Hanau and extensive experience in MOX fuel operation. German utilities and Siemens/KWU planned and developed this capability beginning in 1980. The industry has demonstrated the feasibility of recycling second-generation plutonium separated from spent MOX fuel, as well as the recycling of enriched reprocessed uranium.

Although Germany has abandoned its domestic R&D and industrial plans for reprocessing, it continues to participate in technology development with the French. Recently, Germany has become part owner of the UP3-800 reprocessing facility at LaHague, France. In addition, extensive plans and demonstrations for plutonium and uranium recycling with MOX fuels are underway. With France, the UK, and Italy, Germany is one of the principle contributors to the European Fast Reactors Utilities Group.

India

India is committed to a closed fuel cycle and has operated reprocessing facilities for over twenty-five years. Four reprocessing plants are currently in operation or under construction. India's first plant, a demonstration facility at Trombay, was commissioned in 1964 with a capacity of 50 MTHM per year. A 100 MTHM-per-year plant at Tarapur was commissioned in 1985. Phase I of the Kalpakkam plant has a capacity of 125 MTHM per year and Phase II has a capacity of 1,000 MTHM per year. In 1991, India also began offering reprocessing services for research reactor spent fuels as part of a larger effort to export the country's nuclear technology and consultant services worldwide.

China

In the 1950s, the Chinese received Soviet technology and assistance on nuclear fuel reprocessing, then proceeded domestically to build reprocessing facilities for military purposes at Subei in Gansu Province. A long-term research and development program preceded the decision to build a 26 MTHM-per-year reprocessing pilot plant at Lanzhou in the Gansu Province; this new plant is scheduled to start operations in 1998. In addition, two commercial-scale reprocessing facilities are scheduled for completion in 1995 and 2000 in the Zhejiang and Xinjiang Provinces. The Chinese approach to developing reprocessing

© NUEXCO 1992

technology has been a careful, thorough process, developed over a long period of time. It represents a studied choice of reprocessing and recycling plutonium and uranium to make efficient use of the material, as well as the geographical and labor resources of China.

Other Countries

Other countries committed to reprocessing that have relatively small reprocessing facilities under construction, operating, or shut down include Belgium, Italy, and Argentina. Six more countries have selected the reprocessing cycle, but have no domestic reprocessing capability: Bulgaria, Czech and Slovak Federal Republic, Hungary, Finland, The Netherlands, and Switzerland.

COUNTRIES NOT USING REPROCESSING

USA

The USA is committed to the once-through, or open nuclear fuel cycle, followed by storage and disposal. No commercial reprocessing plants are in operation today, although reprocessing facilities for military purposes that began operating in the early 1950s at Hanford, Washington; Savannah River, South Carolina; and Idaho Falls, Idaho, are still in operation. The Nuclear Fuel Services (NFS) plant at West Valley, New York, operated from 1967 to 1972, reprocessing 600 MTHM of spent fuel. The plant was to have been expanded to a 750 MTHM-per-year capacity, but instead was shutdown by NFS in 1972 as uneconomic. In the same time period, a prototype plant was built and tested by General Electric at Morris, Illinois, but never began operation due to technical problems and the lack of need for reprocessing. In 1976, following a federal ban on commercial reprocessing due to proliferation concerns, Allied-General ceased work on a plant at Barnwell, South Carolina, that had progressed to the operating license stage. Exxon performed two feasibility studies for 1,500 MTHM-per-year plants, neither of which reached the construction stage.

Nuclear utilities in the USA operated from 1957 to 1977 under the assumption that the plutonium in their spent fuel had a positive cash value and rate payers were given credits long before utilities could expect income from plutonium. Since reprocessing and recycling never occurred, the plutonium benefits never came about. A federally financed study of reprocessing and recycling in the early 1970s favored recycling, but the 1976 ban ended the reprocessing of civilian spent fuel. The ban was lifted in 1981, but the lack of facilities to utilize reprocessed uranium and plutonium made reprocessing a non-viable commercial business. No private firm in the USA has since ventured into commercial reprocessing.

Although the USA has selected the once-through commercial fuel cycle over reprocessing, little progress seems to have been made on spent fuel disposal. No permanent repository for spent fuel exists in the USA, nor does any interim, centralized storage facility exist, in spite of many years of planning for a permanent geological repository and a monitored retrievable storage facility. Spent fuel continues to be stored by utilities on site in upgraded spent fuel pools inside the reactor containment buildings, but this storage space is limited. Some utilities have built on-site storage facilities outside the containments, but such storage is becoming more difficult to license. By the late 1990s, US utilities may be faced with the choice of sending spent fuel overseas for reprocessing or shutting down nuclear units.

Canada and Sweden

Canada and Sweden are other examples of countries utilizing nuclear power, but not using reprocessing. Canada is committed to the CANDU heavy water reactor technology that uses natural uranium fuel. The economics of reprocessing depleted uranium from HWRs has long been non-viable, thereby dictating Canada's decision not to reprocess.

Initially, Sweden elected the reprocessing option, providing funds for the development of the UP3 facility in France, and signing contracts to have its spent fuel reprocessed. However, Sweden reversed its decision and has now elected to follow an open fuel cycle with permanent disposal of the country's spent fuel. This decision resulted primarily from proliferation concerns, as well as ecological concerns regarding nuclear wastes.

Several other countries also have not committed to reprocessing and have opted for interim storage until a final decision is reached. **Table 2** lists the spent fuel management approaches in some selected countries.

© NUEXCO 1992

Table 2
SPENT FUEL MANAGEMENT BY COUNTRY

Country	Interim Storage	Reprocessing	Permanent Disposal
Argentina	●	■	
Belgium		■	
Brazil	●		
Bulgaria		■	
Canada			▼
China		■	
Commonwealth of Independent States		■	
Czech and Slovak Federal Republic		■	
Finland	●	■	
France		■	
Germany	●	■	
Hungary		■	
India		■	
Italy		■	
Japan		■	
Mexico	●		
Netherlands		■	
Pakistan	●		
Slovenia	●		
South Africa	●		
South Korea	●		
Spain	●		
Sweden			▼
Switzerland		■	
United Kingdom		■	
USA			▼

Source: *International Atomic Energy Agency*

CONCLUSION

Reprocessing of spent nuclear fuel is a relatively simple, well-developed, and successful technology. Large, expensive reprocessing facilities are in use, principally in the UK and France, and are under construction in Japan and the CIS. As in most industrial processes, the viability of the process depends on the usefulness of its function and products, operational costs, and the economics of waste disposal. The current situation for nuclear fuel reprocessing is that the products—plutonium and reprocessed uranium—are not economical to use. There are insufficient facilities in place to fabricate and use the plutonium as fuel, and there is little use for reprocessed uranium as long as fresh uranium remains inexpensive. The result is that most of the plutonium and uranium from reprocessing is stored temporarily, waiting to be recycled as fuel or possibly to be disposed of permanently. Also, plutonium and uranium from proposed dismantlement of nuclear weapons threaten to increase temporary storage stockpiles.

In addition to the storage of plutonium and reprocessed uranium, the high-level waste (HLW) from reprocessing must be stored temporarily as well, since no permanent HLW disposal facilities have been built, in spite of available and proven technology. Spent nuclear fuel in the open nuclear fuel cycle also is being stored temporarily at reactor sites, awaiting the construction of the same HLW disposal facilities. The current temporary storage of the products of both the closed and the open nuclear fuel cycles cannot go on indefinitely, and reprocessing cannot be justified given the current lack of need for its products. To alleviate these end-of-fuel-cycle problems, two solutions are needed: permanent HLW disposal provisions and increased plutonium utilization. Plutonium will be used when MOX fuel is fabricated and burned in LWRs, and when plutonium-using fast breeder reactors are built. HLW disposal will be accomplished once permanent disposal facilities can be sited, constructed and licensed. These two solutions apply worldwide and must be implemented at national levels in order to maintain fuel cycle options and to assure the viability of the nuclear electric power industry.

Charles E. Foreman

© NUEXCO 1992

NUCLEAR INDUSTRY CALENDAR

1992

June 23-24 ***Nuclear Forum '92*** (Royal Garden Hotel, London, United Kingdom).
Sponsored by the British Nuclear Forum.
Contact: Ms. Ipek Yigit, Manager for Public and Industrial Affairs, British Nuclear Forum; phone: 071-828-0116; Fax: 071-828-0110; Address: 22 Buckingham Gate, London, SW1E 6LB, England.

Sept. 9-11 ***Uranium Institute 17th Annual Symposium*** (London, United Kingdom).
Contact: 44-71-225-0303; Fax: 44-71-225-0308.

Sept. 20-23 ***International Uranium Seminar '92*** (Hyatt Regency Hotel, Lake Tahoe, Nevada).
Sponsored by the U.S. Council for Energy Awareness.
Contact: USCEA Conference Office; 202-293-0770; Telex: 7108249602; Fax: 202-785-4113.

Sept. 21-23 ***2nd International Conference on Training for Operation & Maintenance in the Nuclear Industry***
(The Moat House International Hotel, Stratford-upon-Avon, United Kingdom).
Sponsored by the Institution of Nuclear Engineers.
Contact: INE Conference Secretary; 081-698-1500 or 081-698-4750; Fax: 018-695-6409.

Sept. 29-Oct. 1 ***Crisis/Emergency Information Planners' Workshop*** (Loews L'Enfant Plaza, Washington DC)
Sponsored by the U.S. Council for Energy Awareness.
Contact: USCEA Conference Office; 202-293-0770; Telex: 7108249602; Fax: 202-785-4113.

Oct. 18-22 ***AMC Mining Convention*** (Las Vegas, Nevada)
Sponsored by the American Mining Congress.
Contact: AMC Convention Office; 202-861-2800; Fax: 202-861-7535.

Oct. 19-23 ***International Symposium on Geological Disposal of Spent Fuel, High-level and Alpha-bearing Wastes***
(Antwerp, Belgium).
Sponsored by the International Atomic Energy Agency.
Contact: IAEA, P.O. Box 100, A-1400 Vienna, Austria.

Nov. 15-18 ***International Nuclear Energy Forum*** (Fairmont Hotel, Chicago, Illinois).
Sponsored by the U.S. Council for Energy Awareness.
Contact: USCEA Conference Office; 202-293-0770; Telex: 7108249602; Fax: 202-785-4113.

Nov. 15-20 ***American Nuclear Society Winter Meeting*** (McCormick Center Hotel, Chicago, Illinois).
Contact: ANS Meetings Department; 708-352-6611.

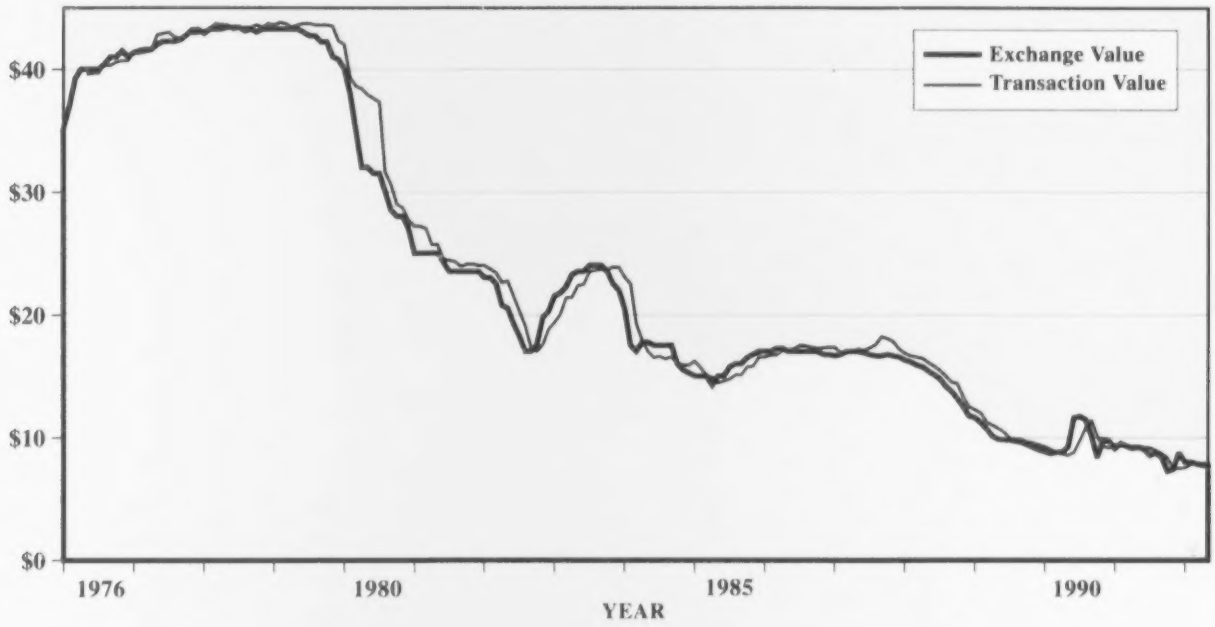
© NUEXCO 1992

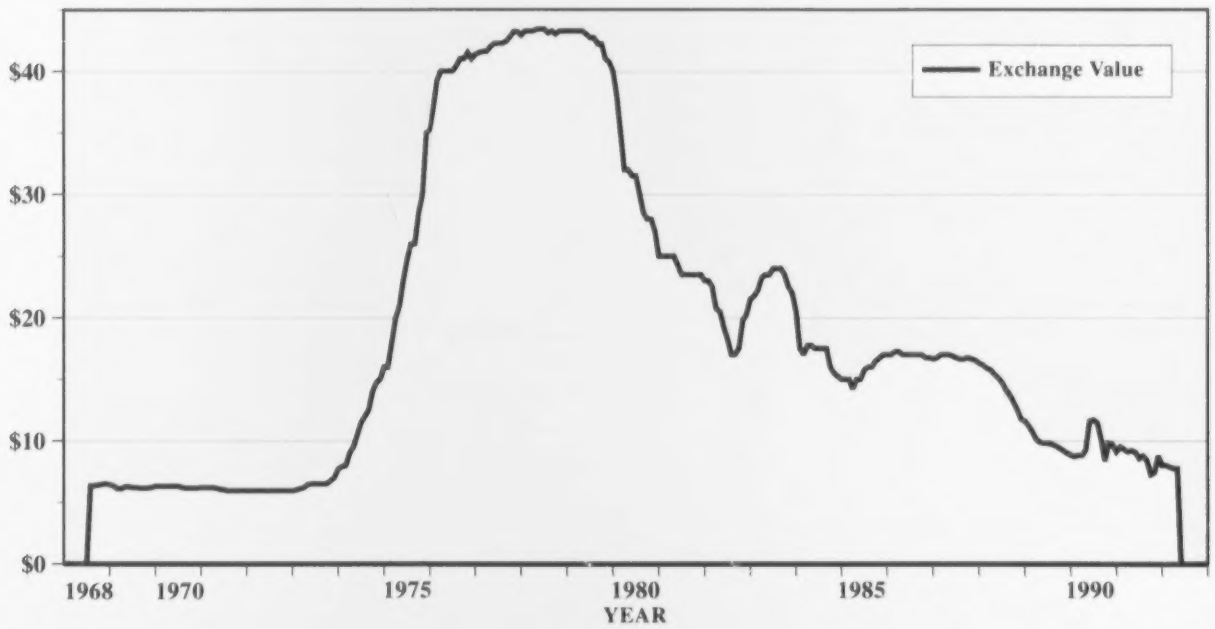
NUEXCO

HISTORICAL MARKET DATA

NUEXCO HISTORICAL EXCHANGE VALUE AND TRANSACTION VALUE

(in US dollars per pound U_3O_8)





© NUEXCO 1992

HISTORICAL MARKET VALUES

Exchange Values

Year	Determined as of the last day of the month indicated ($US/lb U_3O_8)											
	Jan	**Feb**	**March**	**April**	**May**	**June**	**July**	**Aug**	**Sept**	**Oct**	**Nov**	**Dec**
1968	—	—	—	—	—	—	—	6.35	6.35	6.40	6.45	6.50
1969	—	6.35	6.10	6.10	6.25	6.25	6.20	6.20	6.15	6.15	6.15	6.20
1970	6.30	6.30	6.30	6.30	6.30	6.30	6.30	6.20	6.15	6.15	6.15	6.15
1971	6.20	6.20	6.20	6.20	6.15	6.05	6.00	5.95	5.95	5.95	5.95	5.95
1972	5.95	5.95	5.95	5.95	5.95	5.95	5.95	5.95	5.95	5.95	5.95	5.95
1973	5.95	6.00	6.10	6.20	6.45	6.50	6.50	6.50	6.50	6.50	6.75	7.00
1974	7.70	7.90	8.00	9.00	9.50	10.50	11.50	12.00	12.50	14.00	14.75	15.00
1975	16.00	16.00	18.00	20.00	21.00	23.00	24.70	26.00	26.00	28.50	30.00	35.00
1976	35.20	37.00	39.25	40.00	40.00	40.00	40.00	40.40	41.00	41.00	41.50	41.00
1977	41.35	41.50	41.60	41.60	42.00	42.25	42.25	42.25	42.40	42.75	43.20	43.20
1978	42.90	43.25	43.25	43.25	43.40	43.40	43.40	43.10	43.25	43.00	43.25	43.25
1979	43.25	43.25	43.25	43.25	43.25	43.00	42.70	42.70	42.20	42.20	41.00	40.75
1980	40.00	38.00	35.00	32.00	32.00	31.50	31.50	30.00	28.50	28.00	28.00	27.00
1981	25.00	25.00	25.00	25.00	25.00	24.25	23.50	23.50	23.50	23.50	23.50	23.50
1982	23.00	23.00	22.50	20.75	20.50	19.25	18.25	17.00	17.00	17.50	19.75	20.25
1983	21.50	21.75	22.25	23.25	23.50	23.50	24.00	24.00	24.00	23.50	22.50	22.00
1984	20.50	17.50	17.00	17.75	17.75	17.50	17.50	17.50	17.50	16.00	15.50	15.25
1985	15.00	15.00	15.00	14.25	15.00	15.00	15.75	16.00	16.00	16.50	16.75	17.00
1986	17.00	17.00	17.25	17.25	17.00	17.00	17.00	17.00	17.00	17.00	16.75	16.75
1987	16.65	16.75	17.00	17.00	17.00	16.90	16.75	16.65	16.65	16.75	16.65	16.55
1988	16.30	16.15	15.90	15.75	15.40	15.10	14.75	14.15	13.75	13.15	12.50	11.75
1989	11.60	11.20	10.70	10.10	9.85	9.80	9.80	9.70	9.60	9.40	9.20	9.00
1990	8.85	8.70	8.80	8.80	9.25	11.60	11.70	11.45	10.10	8.35	9.80	9.70
1991	9.10	9.50	9.30	9.10	9.20	9.05	8.55	8.75	8.40	7.25	7.40	8.75
1992	8.00	8.00	7.85	7.75	**7.75**							

US Premium (Relative to the Exchange Value)

Year	Determined as of the last day of the month indicated ($US/lb U_3O_8)											
	Jan	**Feb**	**March**	**April**	**May**	**June**	**July**	**Aug**	**Sept**	**Oct**	**Nov**	**Dec**
1986	—	—	—	—	—	—	—	—	—	—	0.65	0.75
1987	0.85	1.00	1.50	1.50	0.90	0.60	2.50	2.35	2.10	1.65	0.85	0.65
1988	0.70	0.50	0.15	0.25	0.60	0.00	0.00	0.00	0.00	0.00	**Discontinued**	

© NUEXCO 1992

NUEXCO

HISTORICAL MARKET DATA

UF_6 Values

Year	Determined as of the last day of the month indicated ($US/kg U as UF_6)											
	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec
1985	—	—	—	40.50	42.50	42.50	44.00	44.50	44.50	46.00	46.00	47.00
1986	47.00	48.00	48.00	48.50	48.25	48.25	48.25	48.00	48.00	48.00	48.00	47.75
1987	47.75	48.00	48.00	48.00	47.75	47.75	47.50	47.00	46.75	47.00	47.00	47.00
1988	46.50	46.00	45.50	45.25	44.75	44.00	42.75	41.00	40.75	39.00	37.50	35.50
1989	34.75	34.00	33.00	30.50	30.25	30.25	30.00	29.75	29.75	28.25	27.75	26.50
1990	25.90	25.25	24.40	24.40	25.50	32.00	32.50	32.25	29 50	24.75	28.75	28.75
1991	27.50	27.75	27.50	27.25	27.60	27.25	25.75	26.25	25.50	22.75	22.75	26.00
1992	24.50	24.25	24.00	23.75	**23.60**							

US Premium (Relative to the UF_6 Value)

Year	Determined as of the last day of the month indicated ($US/kg U as UF_6)											
	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec
1986	—	—	—	—	—	—	—	—	—	—	2.50	2.50
1987	2.50	2.50	3.50	3.00	2.25	1.75	6.50	6.00	4.25	3.10	2.25	2.00
1988	1.25	1.25	0.50	0.50	1.00	0.00	0.00	0.00	0.00	0.00	**Discontinued**	

Conversion Values

Year	Determined as of the last day of the month indicated ($US/lb U as UF_6)											
	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec
1981	1.20	1.20	1.20	1.40	1.15	1.15	1.15	1.10	1.10	1.10	1.20	1.20
1982	1.20	1.20	1.20	1.20	1.00	1.00	1.00	0.90	1.10	1.60	1.45	1.45
1983	1.20	1.40	1.40	1.20	1.20	1.20	1.10	1.10	1.00	0.60	0.60	0.60
1984	0.60	0.30	0.80	0.80	0.80	0.00	0.00	0.80	1.00	1.00	0.80	0.80
1985	1.00	1.00	1.00	1.50	1.50	1.60	1.60	1.60	1.60	1.60	1.60	1.60
1986	1.60	1.80	1.90	1.80	1.80	1.80	1.80	1.90	1.90	1.90	1.80	1.80
1987	1.80	1.80	1.80	1.80	1.80	1.80	1.90	1.90	1.90	1.90	1.90	1.90
1988	1.90	1.80	1.80	1.80	1.80	1.80	1.85	1.95	1.95	1.95	1.95	1.95
1989	1.95	1.95	1.95	1.95	1.95	1.95	1.95	1.90	1.90	1.80	1.75	1.65
1990	1.50	1.50	1.45	1.45	1.45	1.45	1.45	1.45	1.45	1.45	1.45	1.45
1991	1.45	1.45	1.45	1.45	1.50	1.50	1.50	1.60	1.55	1.55	1.55	1.55
1992	1.60	1.60	1.60	1.60	**1.60**							

© NUEXCO 1992

Transaction Values

Determined as of the last day of the month indicated ($US/lb U_3O_8)

Year	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec
1976	—	—	—	—	39.60	39.70	39.70	40.40	40.30	40.60	40.70	40.70
1977	41.30	41.30	41.40	41.50	42.80	42.90	43.00	42.60	42.50	42.80	42.90	42.90
1978	43.10	43.30	43.70	43.60	43.60	43.20	43.30	43.40	43.40	43.60	43.40	43.70
1979	43.60	43.80	43.70	43.40	43.60	43.70	43.70	43.60	43.60	43.60	43.50	42.30
1980	42.00	39.30	38.60	38.40	37.90	37.60	37.30	31.60	30.60	29.00	28.70	27.70
1981	27.20	27.20	27.00	25.70	25.70	24.50	24.40	24.30	23.90	24.10	24.10	24.00
1982	24.00	23.70	23.40	22.60	22.70	21.50	20.30	19.10	17.30	17.00	17.55	18.80
1983	19.35	20.00	21.35	21.40	22.35	22.45	23.50	23.60	23.65	23.65	23.85	23.85
1984	23.05	22.50	19.25	17.90	17.00	16.50	16.60	16.40	16.55	16.05	15.90	15.90
1985	16.20	15.70	15.05	14.90	14.45	14.60	14.75	15.10	15.10	15.75	15.80	16.55
1986	16.55	16.70	16.70	17.10	17.15	17.20	17.50	17.45	17.35	17.25	17.30	17.35
1987	17.35	16.90	16.95	17.00	17.20	17.10	17.30	17.55	18.20	18.05	17.80	17.20
1988	16.85	16.65	16.55	16.45	16.10	15.80	15.45	15.00	14.50	14.40	13.30	12.50
1989	12.25	12.00	11.25	11.00	10.75	10.45	9.95	9.80	9.80	9.65	9.55	9.40
1990	9.25	9.05	8.75	8.65	8.55	8.80	9.75	10.80	11.40	10.10	9.30	9.15
1991	9.40	9.45	9.35	9.30	9.30	9.20	9.15	8.95	8.70	8.35	7.45	7.50
1992	7.55	7.80	7.95	7.90	**7.85**							

SWU Values

Determined as of the last day of the month indicated ($US per SWU)

Year	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec
1986	80	80	80	80	75	78	78	78	78	78	80	80
1987	80	80	77	77	75	73	75	75	73	69	73	73
1988	73	73	70	68	68	68	68	65	65	65	65	65
1989	65	67	67	67	66	66	66	65	63	59	57	54
1990	54	50	50	50	50	50	50	50	50	51	51	51
1991	51	50	52	52	54	59	66	67	67	68	68	70
1992	71	70	69	67	**65**							

© NUEXCO 1992

NUEXCO

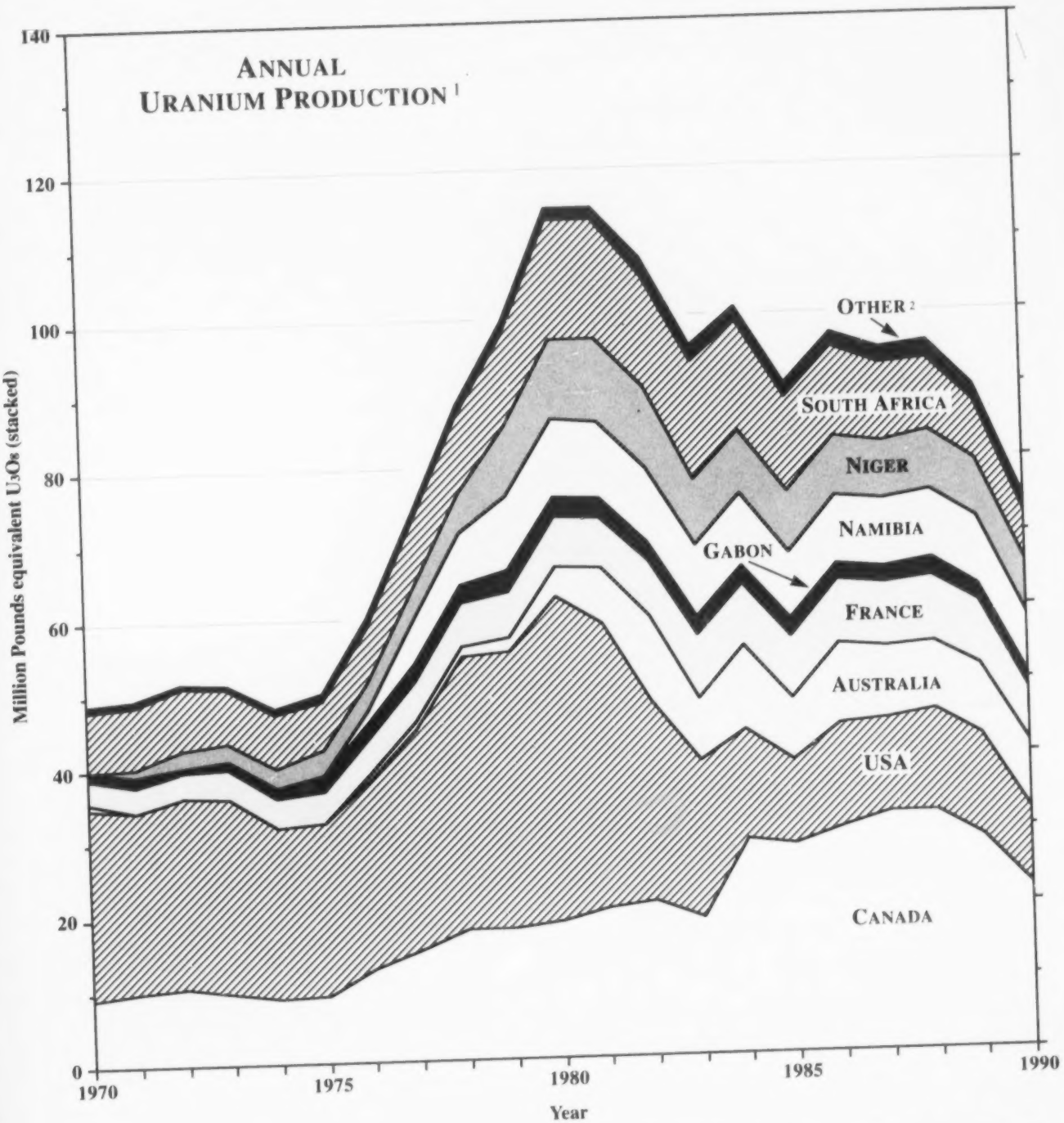
HISTORICAL MARKET DATA

Loan Rates

Year	Determined as of the last day of the month indicated (Percent per Annum)											
	Jan	**Feb**	**March**	**April**	**May**	**June**	**July**	**Aug**	**Sept**	**Oct**	**Nov**	**Dec**
1968	—	—	—	—	—	—	—	4.00	4.00	4.00	4.00	4.00
1969	4.00	4.00	5.00	5.00	5.00	5.00	5.00	5.00	6.00	6.00	6.00	6.00
1970	6.00	6.20	6.40	6.50	6.50	6.50	6.50	5.00	6.50	6.00	5.50	5.50
1971	5.00	4.75	4.75	4.75	5.00	5.25	5.25	5.25	5.25	5.25	4.50	4.50
1972	4.00	4.00	4.00	4.50	4.50	4.50	5.00	5.00	5.00	5.00	5.00	5.00
1973	5.50	5.50	5.75	5.75	6.00	6.25	7.00	7.00	7.00	7.00	7.50	8.00
1974	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00
1975	8.00	7.00	7.00	7.00	7.00	6.50	6.50	6.50	6.50	6.50	6.50	6.50
1976	6.50	6.50	6.50	6.50	*	*	*	*	*	*	*	*
1977	*	*	*	*	6.50	6.50	6.50	6.75	7.25	7.25	7.25	7.25
1978	7.25	7.00	7.00	7.00	7.00	7.50	7.75	7.75	7.75	7.00	7.00	7.00
1979	7.00	7.00	7.00	7.00	7.00	7.00	7.00	7.00	7.00	7.00	7.00	7.00
1980	7.00	7.00	7.00	7.00	7.00	7.00	7.00	7.00	7.00	7.00	7.00	7.00
1981	7.00	7.00	7.00	7.00	7.00	5.50	5.50	5.50	5.50	6.00	6.00	6.00
1982	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00
1983	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00
1984	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00
1985	6.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00
1986	5.00	5.00	5.00	5.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00
1987	3.00	3.00	3.00	3.00	3.00	3.00	3.00	4.00	4.00	4.00	3.50	3.50
1988	3.50	3.50	3.50	3.50	3.50	3.50	3.50	3.50	3.50	3.50	3.50	3.50
1989	3.50	3.50	3.50	3.50	3.50	3.50	3.50	3.50	3.50	3.50	3.50	3.50
1990	3.50	3.50	3.50	3.50	3.50	3.50	3.50	3.50	3.50	3.50	3.50	3.50
1991	3.50	3.50	3.50	3.50	3.50	3.50	3.50	3.50	3.50	3.50	3.50	3.00
1992	3.00	3.00	3.00	3.00	**3.00**							

* Float with Prime Rate

© NUEXCO 1992



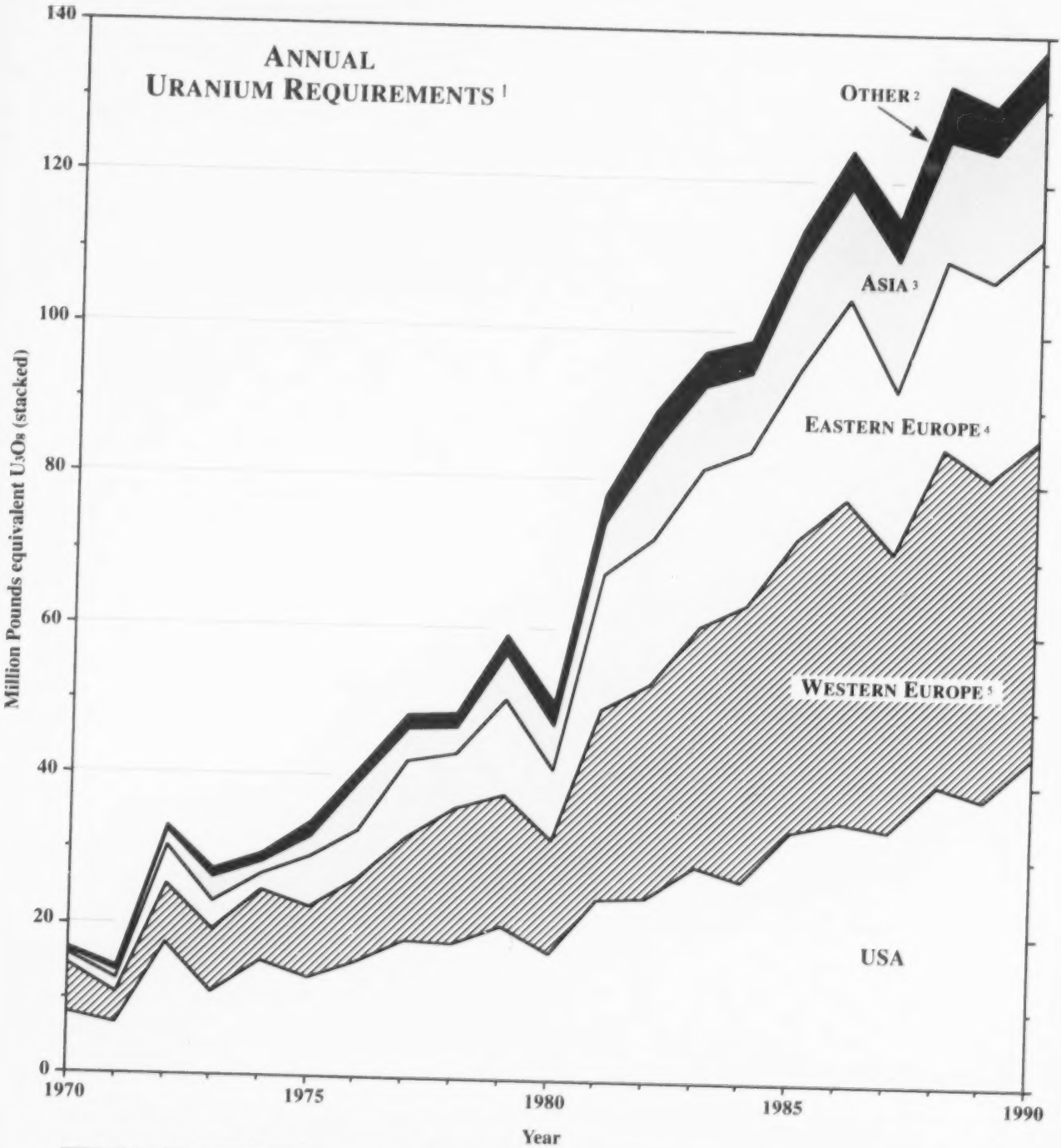
[1] Estimated western world uranium production in 1990 totalled 74.5 million pounds equivalent U_3O_8 — (Australia: 9.1 – Canada: 22.0 – France: 7.4 – Gabon: 1.8 – Namibia: 8.0 – Niger: 7.4 – South Africa: 6.4 – USA: 10.2 – Other[2]: 2.2)

[2] **Other** includes: Argentina, Belgium, Brazil, India, Pakistan, Portugal, Spain, former West Germany, and Yugoslavia (Slovenia).

© NUEXCO 1992

NUEXCO

HISTORICAL MARKET DATA



[1] Calculated by NUEXCO based on actual completion dates and operating performance, and NUEXCO's estimate of enriching tails assay.
[2] **Other** includes: Argentina, Brazil, Canada, India, Mexico, Pakistan, and South Africa.
[3] **Asia** includes: Japan, People's Republic of China, South Korea, and Taiwan.
[4] **Eastern Europe** includes: Bulgaria, Czechoslovakia, former East Germany, Finland, Hungary, former Soviet Union, and Yugoslavia (Slovenia).
[5] **Western Europe** includes: Belgium, France, former West Germany, Italy, The Netherlands, Spain, Sweden, Switzerland, and UK.

© NUEXCO 1992

Australia

Year	Period [1]	Consumer Price Index [2] (1989/1990 = 100)	Price Index of Materials Used in Manufacturing Industry — All Groups [3] (1984/1985 = 100)	Average Weekly Ordinary Time Earnings — Adult Males — Australia [4] (Australian dollars)	Award Rates of Pay Indexes Australia - Adult Males In Mining Wage Earners, Weekly Rates [5] (June 1985 = 100)
1980	Avg.	47.4 R	83.1	—	69.6
1981	Avg.	51.9 R	85.9	—	76.1
1982	Avg.	57.7 R	89.0	—	86.4
1983	Avg.	56.9 R	96.9	—	89.9
1984	Avg.	66.0 R	98.0	—	96.0
1985	Avg.	70.5 R	107.3	—	100.0
1986	Avg.	76.9 R	101.5	—	104.9
1987	Avg.	83.4 R	108.9	465.88	112.9
1988	Avg.	89.4 R	111.8	496.90	115.4
1989	Avg.	96.2 R	117.0	534.65	126.0
1990	Avg.	103.2 R	123.4	571.43	129.7
1991	Avg.	106.5 R	120.1	600.35	133.8
Jan	1991	—	125.6	—	132.0
Feb	1991	—	121.5	597.70	133.0
Mar	1991	105.8	119.1	—	133.3
Apr	1991	—	117.6	—	133.5
May	1991	—	117.8	592.00	133.5
June	1991	106.0 R	120.4	—	133.5
July	1991	—	120.4	—	133.6
Aug	1991	—	119.9	599.50	133.9
Sept	1991	106.6 R	118.3	—	134.2
Oct	1991	—	118.7	—	134.2
Nov	1991	—	120.6	612.20	134.4
Dec	1991	107.6 R	121.2	—	134.4
Jan	1992	—	120.9	—	134.6
Feb	1992	—	120.9	—	—
Mar	1992	107.6	120.0		

P = Preliminary **R** = Revised since last month

[1] Monthly data for the period 1967 to 1990 appears in NUEXCO Monthly Report 278.

[2] Weighted average of six State capital cities (1975 to 1980), and eight capital cities from 1981 (Base: Financial year July 1989 to June 1990 = 100.0). Figures shown at end of quarter represent quarterly average. Base year changed from 1980/81 in Monthly Report 286.

[3] Australian Bureau of Statistics, Canberra: "Price Index of Materials Used in Manufacturing Industry" (CATALOGUE No. 6411.0).

[4] Australian Bureau of Statistics, Canberra: "Award Rates of Pay Indexes, Australia" (CATALOGUE No. 6312.0). Figures for the latest fourteen months shown are subject to revision.

[5] Australian Bureau of Statistics, Canberra: "Average Weekly Earnings, States & Australia" (CATALOGUE No. 6302.0).

© NUEXCO 1992

NUEXCO

GOVERNMENT STATISTICS

Canada

Year	Period	Industrial Products Price Index: All Commodities [1] (1986 = 100) [2]	Consumer Price Index: All Items (1986 = 100) [3]	Wage-earner Data: Average Hourly Earnings (C$) [4] Uranium Mines (SIC 057)	Metal Mines (SIC 051-059)	Mines, Quarries and Oil Wells (SIC 051-099)	Metal Rolling, Casting and Extruding (SIC 298)	Chemicals and Chemical Products Industries (SIC 372-379)
1980	Avg.	75.9	67.2	—·—	—·—	—·—	—·—	—·—
1981	Avg.	83.6	75.5	—·—	—·—	—·—	—·—	—·—
1982	Avg.	89.0	83.7	—·—	—·—	—·—	—·—	—·—
1983	Avg.	92.1	88.5	17.22	14.86	14.18	10.67	11.09
1984	Avg.	96.3	92.4	17.89	15.85	14.97	11.11	11.68
1985	Avg.	99.0	96.0	18.53	16.47	15.56	11.85	12.12
1986	Avg.	100.0	100.0	19.38	16.70	15.76	12.28	12.58
1987	Avg.	102.8	104.4	20.12	17.15	16.11	12.58	13.20
1988	Avg.	107.2	108.6	20.91	18.51	16.95	13.17	13.77
1989	Avg.	109.4	114.0	21.97	20.02	18.41	13.71	14.16
1990	Avg.	109.7	119.4	22.90	20.93	19.12	14.62	15.28
1991	Avg.	108.7	126.2	24.35	22.27	20.28	14.83	16.45
Jan	1991	111.1	125.0	23.79	21.79	19.78	14.66	15.89
Feb	1991	110.6	125.0	25.23	22.45	20.13	14.63	16.10
Mar	1991	109.8	125.5	24.19	22.22	20.27	15.21	16.47
Apr	1991	109.1	125.5	24.77	22.50	20.31	14.63	16.64
May	1991	108.6	126.1	24.38	22.17	20.25	15.05	16.55
June	1991	108.5	126.7	23.58	22.13	19.90	14.65	16.51
July	1991	108.2	126.8	24.70	22.33	19.93	14.56	16.36
Aug	1991	107.8	126.9	23.78	22.01	20.00	14.62	16.24
Sept	1991	107.6	126.7	24.23	22.27	20.38	14.89	16.47
Oct	1991	107.3 **R**	126.5	24.40	22.26	20.53	15.06	16.55
Nov	1991	107.2 **R**	127.0	24.58	22.44	20.79	14.85	16.62
Dec	1991	107.1 **R**	126.4	24.53	22.70	21.13	15.16	17.04
Jan	1992	107.2	127.0	24.79	22.67	21.20	15.53	16.97
Feb	1992	108.0	127.1	24.42 **R**	22.51 **R**	21.15 **R**	15.92 **R**	16.86 **R**
Mar	1992	108.2 **R**	127.5	24.92 **P**	22.87 **P**	21.21 **P**	15.85 **P**	16.70 **P**
Apr	1992	107.9	127.6	—·—	—·—	—·—	—·—	—·—

P = Preliminary **R** = Revised since last month

[1] Statistics Canada, Prices Division, Ottawa: "Industry Price Indexes" (CATALOGUE 62-011). Indexes for the most recent six months shown are subject to revision. This category was formerly known as "Manufacturing." Monthly data for the period 1967 to 1990 is found in NUEXCO Monthly Report 278.

[2] New Base Year of 1986 as of NUEXCO Monthly Report 266. Previous Base Year was 1981.

[3] New Base Year of 1986 as of NUEXCO Monthly Report 264. Previous Base Year was 1981.

[4] Statistics Canada, Labour Division, Employment and Payrolls Section, Ottawa: "Employment, Earnings and Hours." Monthly data for the period 1983 to 1990 is found in NUEXCO Monthly Report 278.

© NUEXCO 1992

South Africa

Year	Period	Average Declared Working Costs per Metric Ton of Gold Ore Milled [1] (Rand)	Tonnage-Weighted Index of Average Working Costs per Metric Ton of Gold Ore Milled [2] (March 1982 = 100)	Consumer Price Index [3] (1990 = 100)	Production Price Index All Groups [4] (1990 = 100)	Total Employment in Mining and Quarrying [5]	Total Salaries and Wages in Mining and Quarrying [5] (1,000 Rand)
							Annual Total [6]
1980	Avg.	35.50	—	25.5	27.7	709,042	2,237,689
1981	Avg.	41.87	—	29.4	31.5	722,918	2,756,928
1982	Avg.	47.23	103.9	33.7	35.9	702,041	3,181,584
1983	Avg.	51.88	115.0	37.8	39.7	700,901	3,563,282
1984	Avg.	58.95	130.3	42.2	43.0	711,511	4,134,390
1985	Avg.	68.70	151.7	49.1	50.3	724,587	4,778,612
1986	Avg.	80.18	177.9	58.2	60.1	756,637	5,767,950
1987	Avg.	95.01	223.1	67.6	68.5	751,864	6,911,395
1988	Avg.	106.69	241.1	76.2	77.5	705,355	7,774,054
1989	Avg.	116.65	273.0	87.4	89.3	700,360	8,833,934
1990	Avg.	129.37	305.3	100.0	100.0	677,742	10,193,209
1991	Avg.	136.06	322.4	115.2	111.4	630,722	10,934,073
							Monthly Total
Jan	1991	—	—	107.7	108.6	648,944	935,839
Feb	1991	—	—	109.0	109.0	650,948	893,373
Mar	1991	137.66	323.82	110.0	108.2	651,843	924,930
Apr	1991	—	—	111.5	108.8	639,939	887,722
May	1991	—	—	113.2	109.8	630,481	887,107
June	1991	134.65	317.23	114.0	110.3	640,908	890,595
July	1991	—	—	115.5	111.2	637,581	881,182
Aug	1991	—	—	117.1	112.0	633,699	963,710
Sept	1991	137.11	329.05	118.7	113.2	639,535	1,014,424
Oct	1991	—	—	119.8	114.8	584,435	860,529
Nov	1991	—	—	120.9	115.3	602,461	853,864
Dec	1991	134.81	319.33	122.5	115.8	602,486	940,798
Jan	1992	—	—	125.1	115.9	—	—
Feb	1992	—	—	126.2	116.3	—	—
Mar	1992	139.69	331.46	127.3	116.9	—	—
Apr	1992	—	—	128.9	—	—	—

P = Preliminary **R** = Revised since last month

[1] Chamber of Mines of South Africa, Johannesburg: "Analysis of Working Results," published quarterly. Historical Data by month appears in NUEXCO Monthly Report 278.

[2] Page 16 of Report 178 contains description and calculation of index.

[3] Central Statistical Service, Pretoria: All income groups-weighted average, Historical Data by month appears in NUEXCO Monthly Report 278.

[4] Central Statistical Service, Pretoria: All commodities for consumption in South Africa. Base Year changed from 1985 to 1990 in NUEXCO Monthly Report 284.

[5] Central Statistical Service, Pretoria: Historical Data by month appears in NUEXCO Monthly Report 236.

[6] Annual total is shown, rather than monthly average, for indicated year.

© NUEXCO 1992

NUEXCO

GOVERNMENT STATISTICS

United States

Year	Period	Producer Price Index [1] Industrial Commodities (1982 = 100)	Producer Price Index [1] All Commodities (1982 = 100)	Consumer Price Index [2] (1982-1984 = 100)	GNP Implicit Price Deflator [3] (1987 = 100)	Gross Average Hourly Earnings of Production or Non-supervisory Workers (US$) [4] Metal Mining (SIC 10)	Primary Non-ferrous Metals (SIC 333)	Chemicals and Allied Products (SIC 28)	Electric and Electronic Equipment (SIC 36)
1980	Avg.	88.0	89.8	82.4	71.7	10.26	10.63	8.31	6.94
1981	Avg.	97.4	98.0	90.9	78.9	11.55	11.98	9.12	7.62
1982	Avg.	100.0	100.0	96.5	83.8	12.31	12.93	9.96	8.21
1983	Avg.	101.1	101.3	99.6	87.2	12.58	13.43	10.58	8.66
1984	Avg.	103.3	103.7	103.9	91.0	13.05	13.43	11.07	9.04
1985	Avg.	103.7	103.2	107.6	94.4	13.38	13.74	11.57	9.46
1986	Avg.	100.0	100.2	109.6	96.9	12.46	13.48	11.98	9.65
1987	Avg.	102.6	102.8	113.6	100.0	12.52	12.98	12.37	9.88
1988	Avg.	106.3	106.9	118.3	103.9	13.24	13.26	12.71	9.79
1989	Avg.	111.6	112.2	124.0	108.4	13.59	13.72	13.09	10.05
1990	Avg.	115.8	116.3	130.7	112.9	14.10	14.36	13.54	10.32
1991	Avg.	116.5	116.5	136.2	117.0	14.89	14.64	14.07	10.73
Jan	1991	119.3	119.0	134.6	—	14.73	14.63	13.85	10.60
Feb	1991	117.2	117.2	134.8	—	14.80	14.55	13.81	10.59
Mar	1991	115.6	116.1	135.0	115.9	14.93	14.55	13.85	10.55
Apr	1991	115.6	116.0	135.2	—	14.85	14.56	13.96	10.63
May	1991	116.1	116.5	135.6	—	14.79	14.52	14.01	10.66
June	1991	116.1	116.4	136.0	116.8	14.88	14.51	14.05	10.74
July	1991	116.0	116.1	136.2	—	15.09	14.56	14.16	10.77
Aug	1991	116.3	116.2	136.6	—	14.82	14.64	14.06	10.78
Sept	1991	116.3	116.1	137.2	117.4	15.04	14.59	14.21	10.84
Oct	1991	116.7	116.4	137.4	—	14.94	14.75	14.25	10.78
Nov	1991	116.7	116.4	137.8	—	15.29	14.89	14.27	10.88
Dec	1991	116.1	115.9	137.9	117.9	15.13	14.87	14.34	10.96
Jan	1992	115.6	115.6	138.1	—	15.06	14.74	14.30	10.90
Feb	1992	116.0	116.1	138.6	—	15.22 R	14.67 R	14.29	10.90 R
Mar	1992	115.9	116.1	139.3	118.8	15.16 P	14.54 P	14.31 R	10.94 R
Apr	1992	116.3	116.3	139.5	—	—·—	—·—	14.46 P	11.00 P

P = Preliminary **R** = Revised since last month

[1] US Bureau of Labor Statistics, Washington, DC: "Producer Prices and Price Indexes," (formerly "Wholesale Prices and Price Indexes"). Producer Price Indexes are revised four months after they are first released to reflect the availability of late reports and corrections by respondents Historical data is presented in NUEXCO Monthly Report 278.

[2] US Bureau of Labor Statistics, Washington, DC: Consumer Price Index for All Urban Consumers, US City Average, All Items. Historical data is presented in NUEXCO Monthly Report 278.

[3] US Department of Commerce, Washington, DC: Bureau of Economic Analysis, National Income and Wealth Division: "Survey of Current Business." The GNP Implicit Price Deflator is published quarterly, and seasonally adjusted. Historical data is presented in Report 278. Base Year change from 1982 to 1987 in NUEXCO Monthly Report 284.

[4] US Bureau of Labor Statistics, Washington, DC: "Employment and Earnings." All data based on 1972 revision of SIC Manual. Historical data is presented in NUEXCO Monthly Report 278.

© NUEXCO 1992

Uranium Deliveries To The European Community[1]

— Compiled from data published by the Euratom Supply Agency —

Year	Volume of Deliveries to the EC[2] (MTU)	Percentage of Deliveries Made Under Spot Contracts	Medium or Long-Term Contracts[3] Average Price		Spot Contracts[3] Average Price	
			in ECU per pound U_3O_8	in US Dollars per pound U_3O_8	in ECU per pound U_3O_8	in US Dollars per pound U_3O_8
1977	n/a	n/a	n/a	n/a	n/a	$41.00
1978	n/a	n/a	n/a	n/a	n/a	$43.00
1979	10,000	n/a	n/a	n/a	n/a	$44.50
1980	8,600	n/a	n/a	$36.00	n/a	$35.00
1981	13,000	less than 10	n/a	$33.25	n/a	$28.00
1982	12,500	less than 10	ECU 32.25	$32.00	ECU 24.25	$24.00
1983	13,500	less than 10	ECU 34.75	$31.00	ECU 26.00	$23.25
1984	11,000	less than 10	ECU 37.75	$29.75	ECU 24.50	$19.25
1985	11,000	11.5	ECU 38.00	$29.00	ECU 19.50	$15.00
1986	12,000	9.5	ECU 31.50	$31.00	ECU 18.00	$17.75
1987	14,000	17.0	ECU 28.25	$32.50	ECU 15.00	$17.25
1988	12,500	4.5	ECU 26.92	$31.82	ECU 13.65	$16.13
1989	13,500	11.5	ECU 26.63	$29.35	ECU 11.04	$12.19
1990	12,800	16.7	ECU 23.08	$29.39	ECU 7.60	$ 9.68

P = Preliminary **R** = Revised since last month

1 The twelve European Community member nations are Belgium, Denmark, France, Germany, Greece, Ireland, Italy, Luxembourg, The Netherlands, Portugal, Spain, and the United Kingdom; prior to January 1986, Spain and Portugal were not members of the EEC.

2 The only deliveries taken into account are those made to final users, namely the electric utilities or their procurement organizations; deliveries to middlemen or fuel cycle companies are not included. The sales between utilities in the Community are also excluded. The quantities covered are those which were entered into accounting records during the year stated.

3 For deliveries made under medium or long-term contracts (i.e., for which the time between the date of signature and the date of the last delivery exceeds one year) the prices were expressed in seven different currencies. In order to calculate an average price, these prices have been converted into European Currency Units (ECU) and US dollars. The average prices were weighted by quantity and converted on the basis of the average annual exchange rate of the different currencies against the ECU and US dollar. Exchange rates are published by European Communities Statistical Office and the International Monetary Fund.

© NUEXCO 1992

NUEXCO

GOVERNMENT STATISTICS

US Uranium Marketing Data

— Compiled from data published by the US Energy Information Administration [1] —

Year	Total Production (million pounds U_3O_8)	Deliveries to Domestic Utilities From US Suppliers [2] (million pounds U_3O_8)	Average Price of Delivered Uranium [2] ($/lb. U_3O_8)	Quantity of Uranium Imported [3] (million pounds U_3O_8)	Average Price of Imported Uranium ($/lb. U_3O_8)	Quantity of Uranium Exported (million pounds U_3O_8)
1976	25.5	27.6	$16.10	3.6	n/a	1.2
1977	29.9	27.8	$19.75	5.6	n/a	4.0
1978	37.0	31.6	$21.60	5.2	n/a	6.8
1979	37.5	33.0	$23.85	3.0	n/a	6.2
1980	43.7	35.0	$28.15	3.6	$43.10	5.8
1981	38.5	32.6	$34.65	6.6	$32.90	4.4
1982	26.9	23.5	$38.37	17.1	$25.19	6.2
1983	21.2	24.2	$38.21	8.2	$26.16	3.3
1984	14.9	22.5	$32.65	12.5	$21.86	2.2
1985	11.3	21.7	$31.43	11.7	$20.08	5.3
1986	13.5	18.9	$30.01	13.5	$20.07	1.6
1987	13.0	20.8	$27.37	15.1	$19.14	1.0
1988	13.1	17.6	$26.15	15.8	$19.03	3.3
1989	13.8	18.4	$19.56	13.1	$16.75	2.1
1990	8.9	20.5	$15.70	23.7	$12.55	2.0

P = Preliminary **R** = Revised since last month

[1] Sources: 1976-1983: US Department of Energy/Energy Information Administration, *Survey of United States Marketing Activity.* 1984-1990: Energy Information Administration, *Uranium Industry Annual.*

[2] Data for 1976-1981 includes both domestic utilities and agents.

[3] Includes imports by domestic utilities and domestic suppliers.

© NUEXCO 1992

NUEXCO

INTERNATIONAL ADVISORY COMMITTEE

J. Robert (Bob) Wolcott
Chairman
USA

* * *

Lars Halle
Sweden

O. J. C. (John) Runnalls
Canada

George J. Stathakis
USA

James C. C. Stewart
United Kingdom

W. Bryan Webster
USA

Ken C. Whyte
South Africa

REPRESENTATIVES

JAPAN:

Kazuo Yokota
Japan Tech Services
Ohkura Building (3F)
1-4-10 Shiba Daimon
Minato-ku, Tokyo 105, Japan
Telephone: (81-3) 3431-6031, -6034
Fax: (81-3) 3434-6674
Telex: 242-5060 (JATECH J)

SOUTH AFRICA:

Chris I. Von Christierson
Southern Prospecting (Pty) Limited
Mailing Address:
Post Office Box 61409
Marshalltown 2107
Republic of South Africa
Street Address:
7th Floor, Marshall Place
66 Marshall Street
Johannesburg 2001
Telephone: (27-11) 834-4211
Fax: (27-11) 834-6343
Telex: 4-89878-SA

TAIWAN:

Dr. Steve H.K. Wang
Southeast Engineering Corporation
Yu-Ming Mansion
7, Roosevelt Rd., Sec. 1, 7th Floor
Taipei, 10757, Taiwan R.O.C.
Telephone: (886-2) 321-0216
Fax: (886-2) 394-2621
Telex: 11285 (SENCORP)

UNITED STATES:

Harold C. Lindberg
83-A Hardee Lane
Whispering Pines, North Carolina 28327
Telephone: (919) 949-3622
Fax: (919) 949-2626

Ralph O. Smith
141 Braemar Drive
Cheshire, Connecticut 06410
Telephone: (203) 272-6246
Fax: (203) 271-1346

© NUEXCO 1992

INTERNATIONAL HEADQUARTERS

Three Park Central, Suite 1000
1515 Arapahoe Street
Denver, Colorado 80202 USA

Telephone: (303) 899-4500
Fax: (303) 899-4555
Telex: 450202 NUEXCO